the tech engineering news

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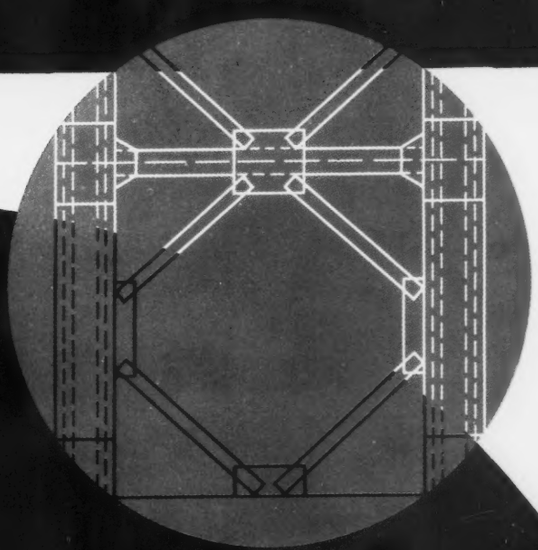
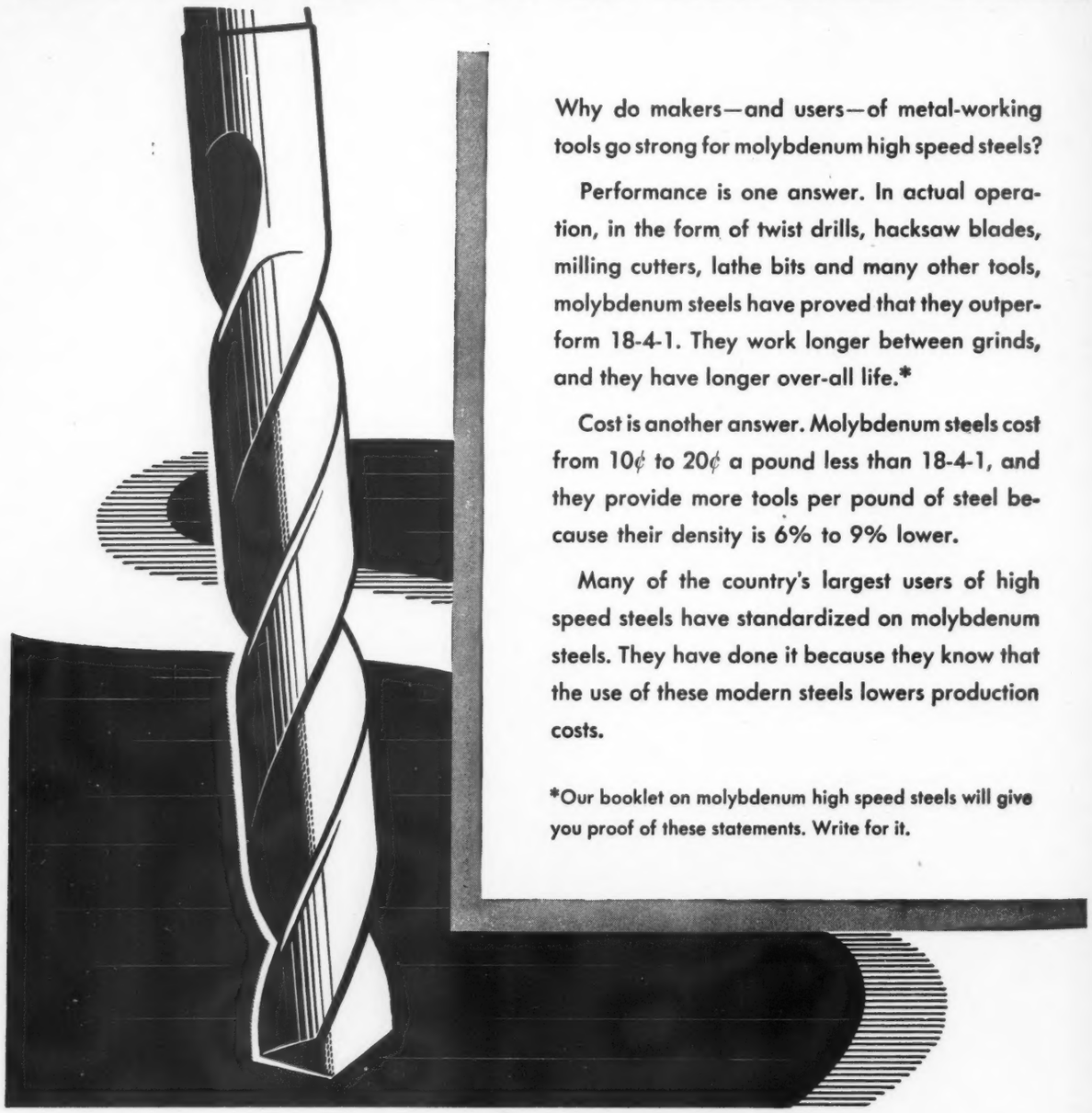


january, 1948

WHY THE TREND IS TO Mo HIGH SPEED STEELS



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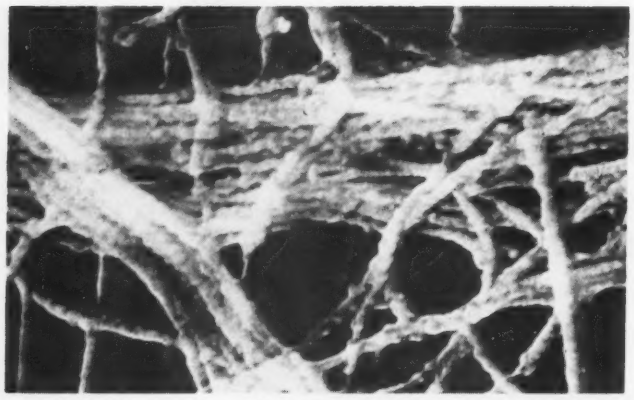
Briefing the News . . .

New Electron Microscope Discoveries About Nerve Structure . . .

NERVES consist of bundles or cables of individual fibers, each fiber originating in a nerve cell and terminating in a muscle, gland, blood vessel or on another nerve cell or sense organ. The signals transmitted over the individual fibers do not stimulate adjacent fibers in the nerve trunk.



Courtesy of Professor Schmitt and Dr. DeRobertis, Department of Biology, M. I. T.

Electron microscope photograph of neurotubules from a human sympathetic nerve fixed in formalin and shadowed with chromium metal. Magnification of 31,000X. Shows parallel packing of the tubules as found in the nerve axon.

A single nerve fiber is a very long cylindrical tube less than a thousandth of an inch in diameter and sometimes many inches long, having a central aqueous core, the *axon*, and a peripheral fatty, *myelin sheath*. Previous investigations by members of the Biology staff at M. I. T., using x-ray diffraction, gave information about the molecular structure of the myelin sheath. From polarized light studies it was deduced that the axon must contain elongate, submicroscopic protein — or nucleoprotein — particles or fibers.

While electrical and chemical studies have greatly advanced our knowledge of the mechanism of impulse transmission in nerves, we still know relatively little about this important physiological process. For further progress it is necessary to investigate the molecular structure of this very efficient piece of biological machinery.

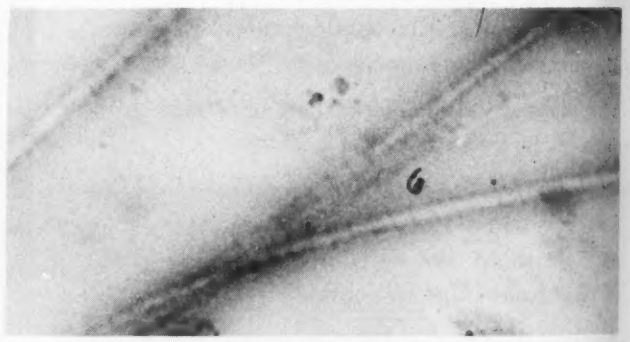
Following the war the Biology staff again took up its study of this problem, making use of the high resolving power of the electron microscope. The first results were communicated at a recent meeting of the Electron Microscope Society of America by Dr. E. De Robertis, an Argentine Fellow of the Guggenheim Foundation, and Professor F. O. Schmitt, Head of the Department of Biology.

After fragmentation of the nerves with a microblendor or with sonic vibrations, the specimens were examined in the electron microscope. In the aqueous core of all the nerve fibers studied, including those of human sympathetic nerves, rabbit and frog sciatics and spinal roots, lobster, horseshoe crab and squid nerves, Doctors De Robertis and Schmitt observed a new type of structure, an example of which is shown in the figure. Characteristic are the dense edges, very low density central core, a periodic cross-banding, and a dense material around the fiber which is diffusible and removable by washing. The evidence thus far available suggests that these fibers are tubular in nature and they have therefore been given the name "neurotubules." They are from 200–800 Angström units ($\sim 10^{-6}$ inches) in width and indefinitely long. Unique among objects thus far discovered, they may play a very important role in nerve function. Further investigations are being made in the Institute's Biology Department to test this aspect.

Ultrasonics . . .

"Silent Sound," of such high pitch that it is inaudible is today performing many strange experiments in United States research laboratories. Few people can hear sounds that vibrate faster than 16,000 times a second, but generators are now producing ultra-sound with a vibration rate as high as 12,000,000 times a second. Because of its very high frequency, ultrasound has a very short wavelength, and can therefore be focused and reflected like light and radar waves.

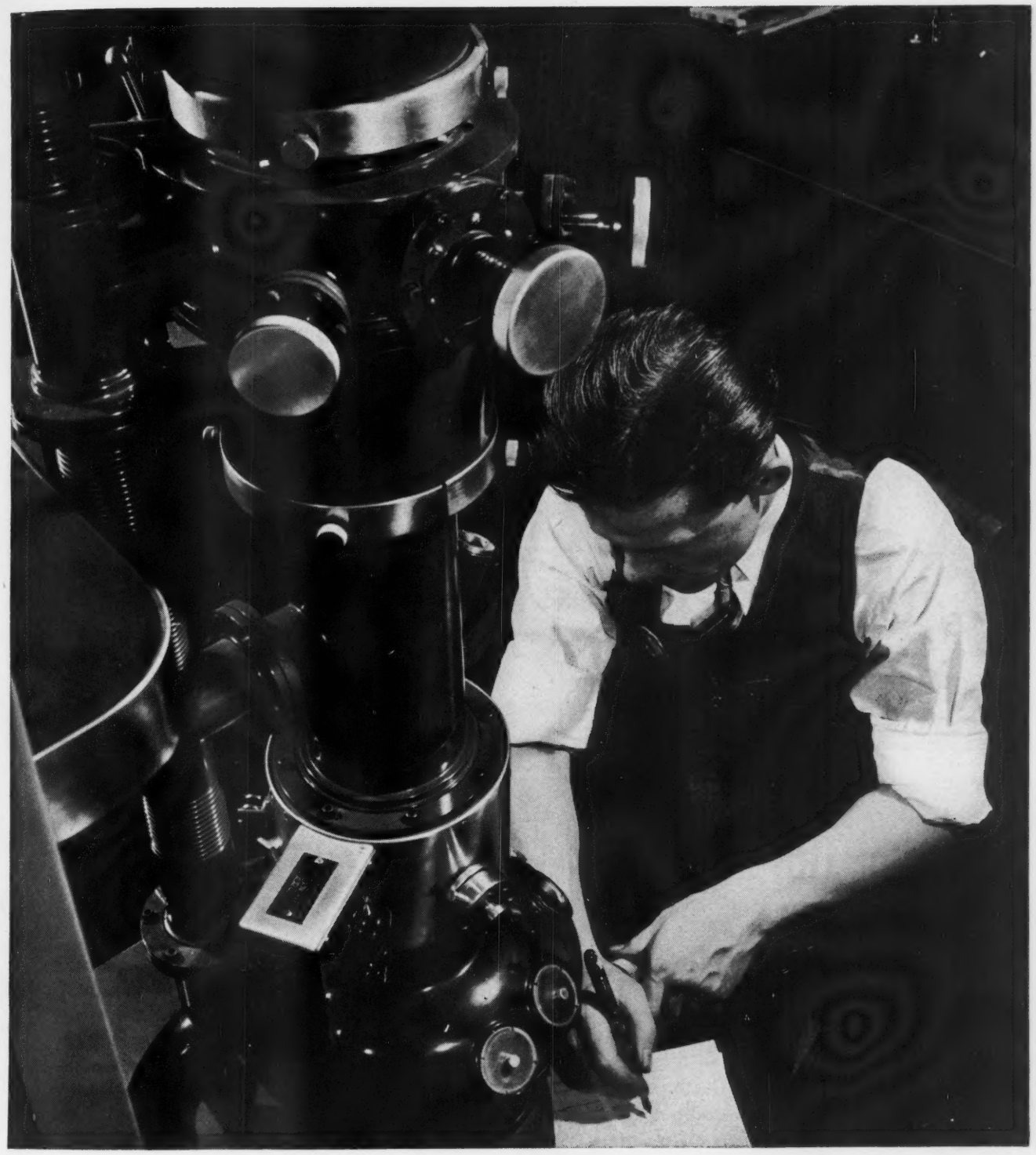
One of the most unusual uses of silent sound is being investigated by medical researchers. Brain operations have been performed on cats and dogs without opening the skull by using waves with a vibration rate of 800,000 times a second. Doctors John G. Lynn and Tracy J. Putnam of the Department of Neurology, Columbia University, have found that they can stimulate temporarily, or destroy, a selected bit of brain tissue by reflecting supersonic waves from a curved crystal, which focusses them to a sharp point within the brain.



Courtesy of Professor Schmitt and Dr. DeRobertis, Department of Biology, M. I. T.

Neurotubules from rabbit sciatic nerve, fixed in formalin and stained with phosphotungstic acid. Magnification 56,000X.

When a sound wave travels, it carries with it an amount of energy proportional to the amplitude of vibration of the sound source. Many of the effects of ultrasonics can be attributed to the conversion of this energy into heat by friction among rapidly oscillating molecules, or into the vibrational energy of tiny particles. Many other effects are as yet unexplained, such as the biological effects of ultrasonic waves. In spite of the limited amount of knowledge that is available on ultrasonics, however, it can be seen that it is a science of tremendous possibilities, using a powerful and radically new form of energy.



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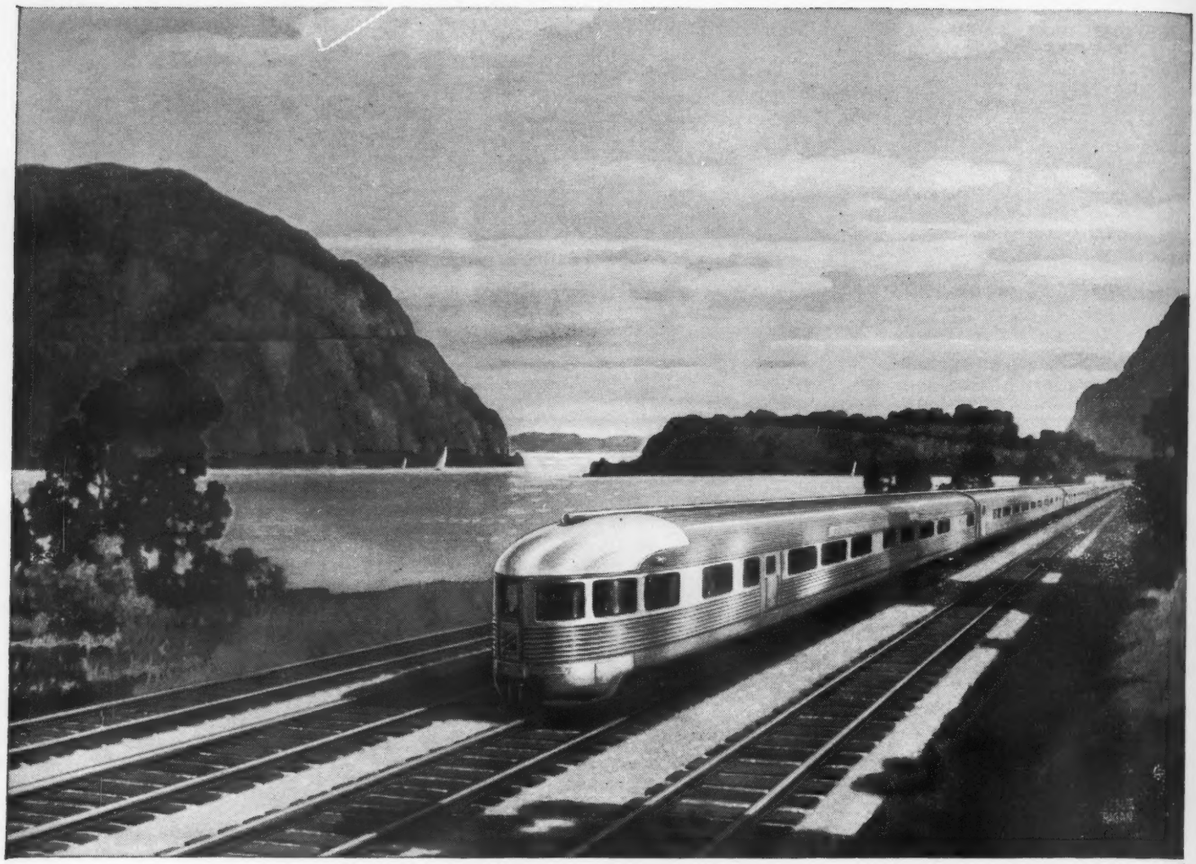

New York Central's Pacemaker approaching Storm King Mountain along the Hudson River

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OF TECHNOLOGY

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Design and drawing by Charles M. Jordan

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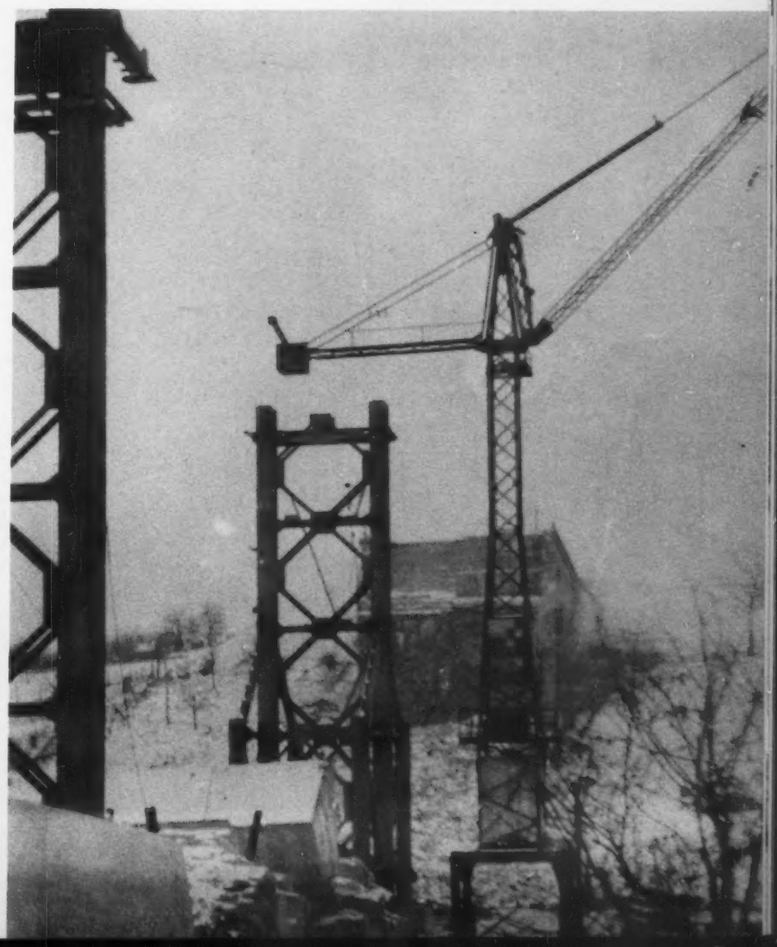
United States Army Engineers at work restoring a demolished bridge in the Autobahn

Gus Mayer



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Clearing debris from construction site to expose footings for replacement piers.

333d Engineers (S.S.) Regiment

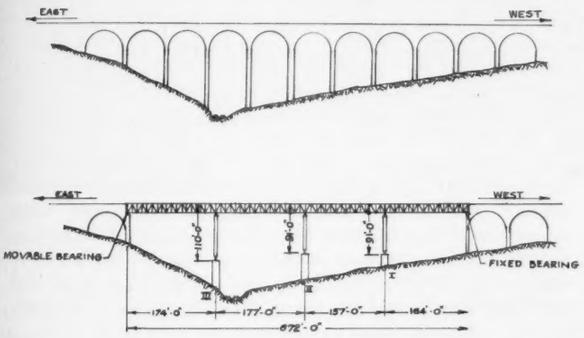
The Kaempfelbach Bridge

Rebuilding a Superhighway Viaduct in Germany

By WERNER H. GUMPERTZ, '48

Formerly Structural Engineer, Office of the Chief Engineer, European Command, United States Army

WHEN the hostilities in Germany ceased, the United States Army was faced with the problem presented by the complete breakdown of the German highway system. Retreating German troops had demolished almost every bridge, large and small, in an attempt to retard the advance of the allied armies. The superhighway system (Autobahn) was the hardest hit, since it included a great number of viaducts and bridges. For reasons of military security and efficiency, it appeared desirable to restore some of the main routes to traffic. Since German construction facilities were almost non-existent, the United States Army took a leading hand in some of the major reconstruction projects. These projects were to be carried out on a semi-permanent basis because the material available was scanty, and the Allies wanted to be sure that the Germans could no longer use their highway system for military purposes.



James Cowdery

On top is a sketch of the Kaempfelbach Bridge before demolition while below, it appears after reconstruction

Major difficulties were encountered in the repairing of a gap in the superhighway which links two state capitals, Munich and Stuttgart, with the United States Army Headquarters in Frankfurt. This gap had been created by the demolition of a large, multiple-arch viaduct crossing the Kaempfelbach valley near Pforzheim, between the towns of Stuttgart and Karlsruhe, and had caused military traffic to be rerouted over a long and dangerous secondary road.

The viaduct was a massive concrete multiple-arch bridge, spanning the valley and a main railroad line (road of the "Orient Express") in thirteen arches, with a length of 1150 feet and a maximum height of 175 feet. All pier foundations contained demolition chambers, a feature which is usually found in all original bridge designs within Germany. The main part of the bridge, consisting of eight arches, was destroyed in the German retreat, leaving a gap 672 feet long. Shortly after the surrender, some of the debris had been removed to clear the double track railroad line.

Company F, 333d Engineer (Special Service) Regiment was given the task of rebuilding the viaduct under the general supervision of the Office of the Chief Engineer.

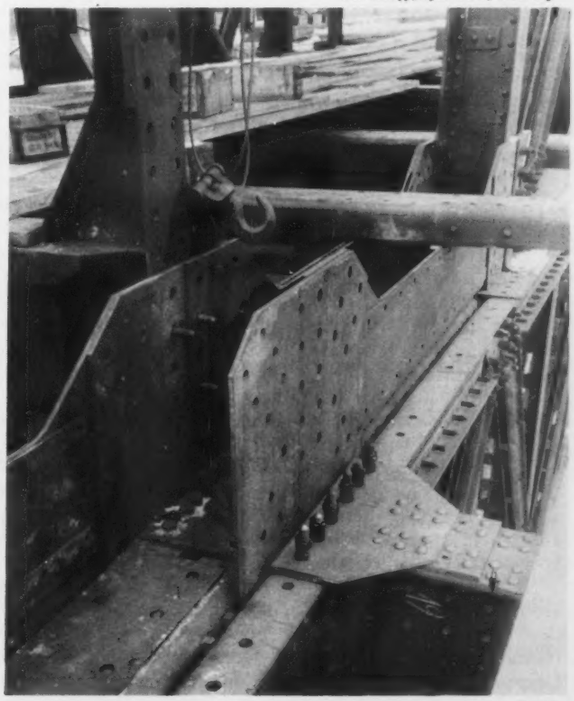
The first task of the constructing unit was to remove huge blocks of broken concrete in order to expose three of the seven footings of the destroyed piers. This work had to be done with extreme caution, especially with regard to blasting, because of the proximity of the heavily used railroad line and the suspicion that some unexploded bombs might be buried under the debris. This suspicion proved to be justified when several unexploded 500-pound aerial bombs were found in the demolition chambers.

It must be borne in mind that construction activities in Germany were complicated by extremely adverse conditions. All materials were scarce and native labor, skilled and unskilled, was very difficult to obtain. In addition, no heavy construction equipment was available other than United States Army equipment.

The original bridge had been wide enough to accommodate the normal Autobahn cross-section, consisting of two separate roadways, each 25 feet wide and

Typical connection detail of components of "S.K.R." bridge during construction

Otto Kropf, Pforzheim, Germany



divided into two lanes. The new bridge was to be built with only one lane in each direction. The structure was to be of the "SKR" type, a German prefabricated war bridge. Originally designed for use on military railroad spans, it is a heavier version of the famous Bailey bridge which was used extensively by the allied armies during the war. The components for the "SKR" bridge, which are connected by bolting, were readily available from captured enemy stocks. Since the total span was 672 feet long, three of the seven footings of the destroyed piers were to be exposed to serve as footings for three intermediate steel piers of the rocker type. Except for the top and bottom cross pieces of these piers, all members were also available in a disassembled condition. The two main trusses are spaced about 17 feet apart, and the bridge deck is formed by precast concrete slabs.

The main truss was planned to be continuous across the whole length of the span. Rocker towers were selected as supports because they alone were narrow enough to fit the existing pier footings. An extension of the footings would have been extremely difficult under the circumstances, since a considerable amount of

Werner H. Gumpertz

Conditions similar to those of the Kaempfelbach Bridge caused a one-sided thrust in this viaduct on the Autobahn between Frankfurt and Cologne. The thrust proved so strong that one arch, which had not been touched by blasting, collapsed.

earth excavation and concrete construction would have been required to widen the base.

Before construction could begin, special consideration had to be given to the arches which remained standing on both sides of the gap. Since the center arches were demolished, the horizontal pressure exerted by the remaining arches on the last remaining pier was no longer counteracted by a similar counter pressure by the neighboring arch now destroyed. As a result, considerable one-sided thrust was exerted on that last pier on either side of the gap. This condition had, of course, not been anticipated in the design of these plain concrete piers. The arches themselves were also subject to a strain because their crown was deflected downward and their span lengthened when the piers deflected horizontally toward the gap.

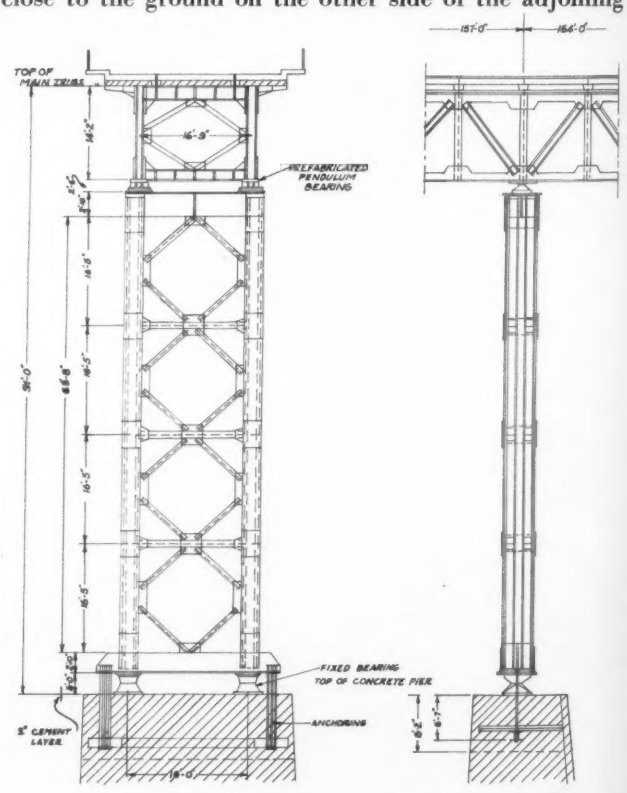
The one-sided thrust in partly destroyed multiple arch bridges had been the cause of the complete destruction of the remaining structure in a number of cases. Numerous observations had been made on destroyed German bridges, showing that much of the destruction

333d Engineer (S.S.) Regiment

The construction of the main truss was started underneath the free end of the temporary cantilever truss which had previously been assembled on the deck of the undestroyed sections.

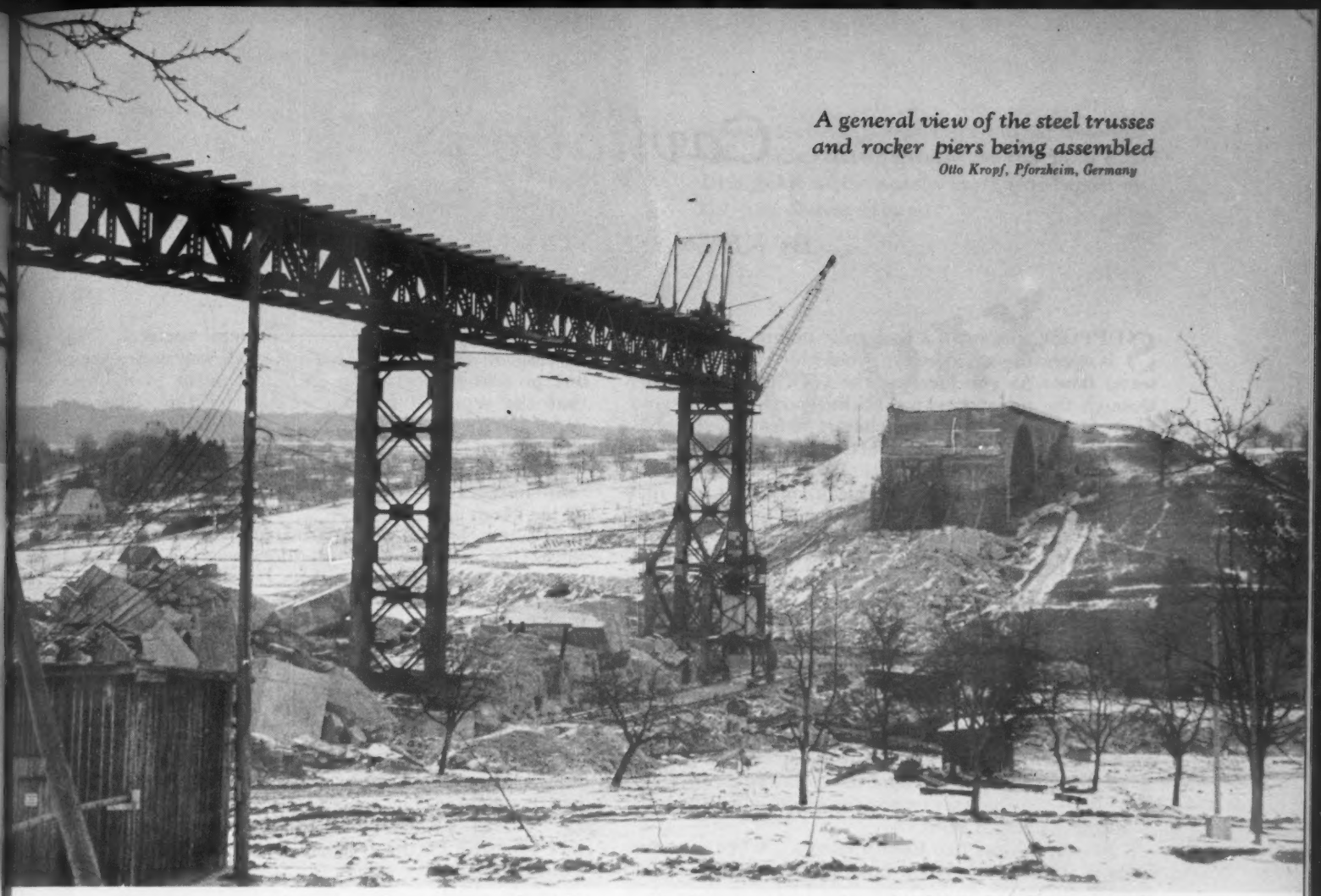
had resulted from the secondary effect of blasting of only one or, at most, a few arches. Consequently, great apprehension was felt for the safety of the remaining structure, and this problem had to be solved before the gap was closed by the erection of the steel structure. In the ensuing weeks, the writer of this article became interested in this problem and eventually suggested a permanent solution on how to counteract the one-sided thrust in a simple and successful way. This solution will be discussed later in this article.

In the meantime, a simple, temporary solution was obtained by "tying back" the two endangered piers with steel cables. The pier tops on each side were cleared and an I-beam placed across the full width, resting on the pier and leaning on the skewback of the arch (see sketch). Similarly, a U-channel was placed close to the ground on the other side of the adjoining



TYPICAL PENDULUM PIER

James Cowdery



A general view of the steel trusses and rocker piers being assembled
Otto Kropf, Pforzheim, Germany

pier. These two crossties were then connected with six evenly spaced steel cables having a tensile strength of 165 tons each. To accommodate the cables, holes were drilled through both piers with great precision in order to avoid contact between each cable and the concrete pier. No allowance was made for the adjustment of the cables under varying temperature and load conditions.

Once the remaining concrete structure was secured, the tops of the end piers were prepared to serve as end abutments for the "SKR" continuous truss. The erection of the truss started on the west side. In order to avoid the use of temporary piers, some of the bridge parts were temporarily assembled on the bridge deck above the last concrete arch and then extended outward as a cantilever. Then the bridge truss proper was suspended from the temporary truss and extended further towards the other end. This method was possible because assembly and disassembly of the prefabricated, standardized truss members could be performed with great speed.

The truss was extended outward until it was connected to the first pier, which had been erected, in the meantime, with the help of a travelling gantry crane. Next, the erection of the truss continued eastward towards the second pier. The temporary truss was left on top of the bridge to serve as a counter weight for the continued cantilever erection of the main truss. To counter the considerable deflection of the free cantilever end, the truss was not set on the final bearing at this time but was placed lower, directly on the abutment. Thus, enough clearance was obtained for the erection of the second rocker bent. This pier was shored temporarily in order to keep it stable until it was connected with the main truss. Next, cantilever erection continued eastward.

In the meantime, when the debris had been cleared from the foot of the easternmost pier, a crack and dislocation were discovered. Since this pier was located very close to the railroad line on a comparatively steep slope, it proved difficult to remove the dislocated stub of the concrete pier. Cold weather and the impossibility of bringing in heavy equipment caused some delay in pouring new concrete to bring the pier up to the level required to receive the rocker bent. After this was accomplished, the main truss was extended until its end was above the third pier. The gantry which had been used to erect the previous two piers could not be used here, because of the interference of the railroad right-of-way, and also because of unfavorable conditions near the third pier. The whole bent was therefore erected by two travelling stiff-leg derricks placed on the free end of the truss. Despite the length of the cantilever part, 165 feet, and the resulting considerable deflection, even the heavy end pieces of the bent were safely hoisted up until the truss finally could be extended to the east abutment. The temporary truss on the west end was then removed and the bridge placed on its permanent bearings.

The next step was the placing of the roadway. In order to facilitate this work, it was decided to prefabricate reinforced concrete sections near the site of the bridge. Wooden forms were set on the unused pavement of the superhighway, and slabs were cast, three of which, placed transversely, would form the width of the roadway; the outside slab sections contained an integrated catwalk. Meanwhile, the bridge had been properly prepared by installation of steel brackets and supports for the roadway. Erection was performed by industrial railroad and truck mounted cranes in a remarkably short time. The total width of the bridge

(*Continued on page 122*)

Cavitation

By KENNETH KOPPLE, '51

SUPPOSE you have a hydraulic pump. Although it is operating at capacity, you decide to speed up the water flow. As you increase the velocity of the water through the apparatus, a crackling noise reaches your ears. You dismantle the machinery to find the trouble. On inspection of the metal parts, you find that pitting is in evidence at certain spots. What is the trouble?

On reading a text on fluid mechanics, you find that the symptoms correspond to those of a phenomenon known as cavitation. When the pressure of a liquid flowing in a system is at a point below the vapor pressure at the surrounding temperature — you read — bubbles of vapor, known as cavities or voids, form in the flowing fluid. When slight variations in temperature or pressure occur, the bubbles violently collapse. Bernoulli's theorem shows that where flow is rapid, pressure is low; therefore, in apparatus where liquid is flowing at high speed, cavitation is prone to occur. The effect was first noted in connection with the then new high speed propellers on British naval vessels of 1894. Since then it has been found in hydraulic pumps, turbines, and in apparatus employing converging-diverging channels for liquid flow.

Cavitation has two known effects. When it occurs in large volume, it causes flow pattern changes which reduce efficiency. In both small and large quantities, it produces a pitting effect on local metal surfaces. The mechanism of this damage is not at all well understood, but present theory and experiment seem to indicate that the repeated impacts caused by the collapsing vapor cavities lead to failure through fatigue.

Some of this damage is no doubt due to electrochemical effects, but the mechanical factors are important enough to make their study worthwhile regardless of the electrical action.

There are three types of instrument for research in cavitation erosion. Each produces results which are in accord, in a general sense, with those produced by the others. One of these is the Venturi type, in which liquid is made to pass at high speed through a converging-diverging channel. Cavities form just downstream from the throat of the tube and collapse in another part of the channel. Samples to be tested are placed at the point at which cavity collapse is the most concentrated.

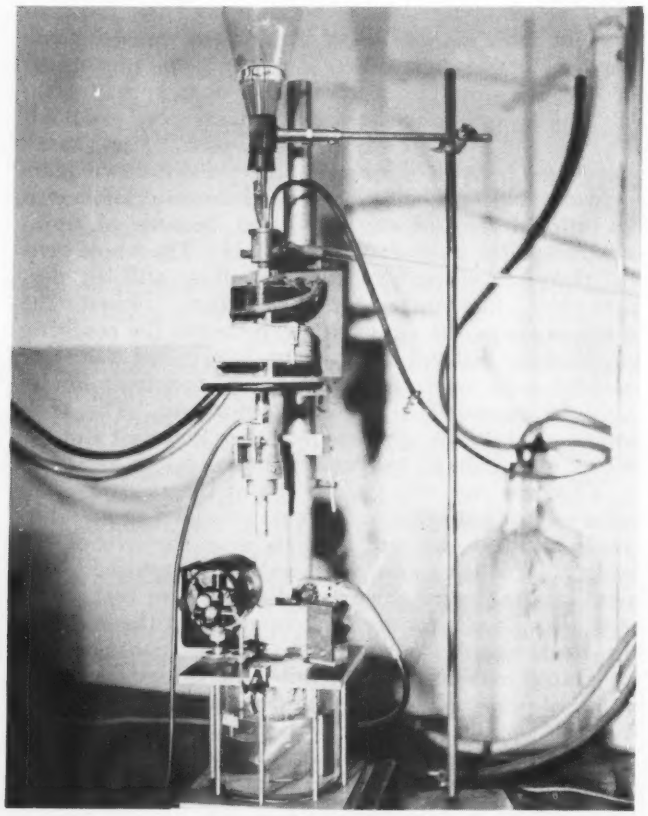
The second form of instrument, the vibratory type, moves a sample perpendicular to its own plane in water or other liquid. The accelerations of the test sample in the liquid are made high enough so that cavitation forms and collapses at the test surface during each cycle of vibration.

Here at M. I. T., in the cavitation laboratory in the Building Three basement, studies of cavitation and erosion have been going on with this type of instrument. This apparatus, designed by Professor B. G. Rightmire, of the Mechanical Engineering Department, is centered around a cylinder of liquid kept at constant temperature into which projects a piston of the test metal. This piston is attached to a vertical nickel rod which is supported laterally but permitted to vibrate freely in an up-and-down manner. Around the nickel rod, but not in contact with it, is a coil of wire connected to an electronic oscillator. When the oscillator is tuned to the resonant frequency of the rod, the latter reacts mechanically to the magnetic field set up around it by the coil. The vibration of the rod causes the test sample to move up and down with a high acceleration, producing cavitation in the liquid in the cylinder. At 6500 cycles per second, an amplitude of .075 millimeters is obtainable. Visible pitting of samples is evident after even a few minutes, while the normal test runs about four hours. The damage done to the sample is measured by its loss in weight which is on the order of one to one hundred milligrams, depending on the material tested.

This apparatus has been used to study the effect on cavitation erosion of several factors. Using ethylene glycol instead of water in the test cylinder, studies were made of the effect of viscosity and surface tension on the degree of erosion. These two quantities were made to take various values through temperature variation. From these experiments, it was concluded that surface tension has no effect on cavitation erosion while viscosity is only of minor importance. The most important single factor influencing the rate of erosion with different liquids appeared to be the density of the fluid.

(*Continued on page 130*)

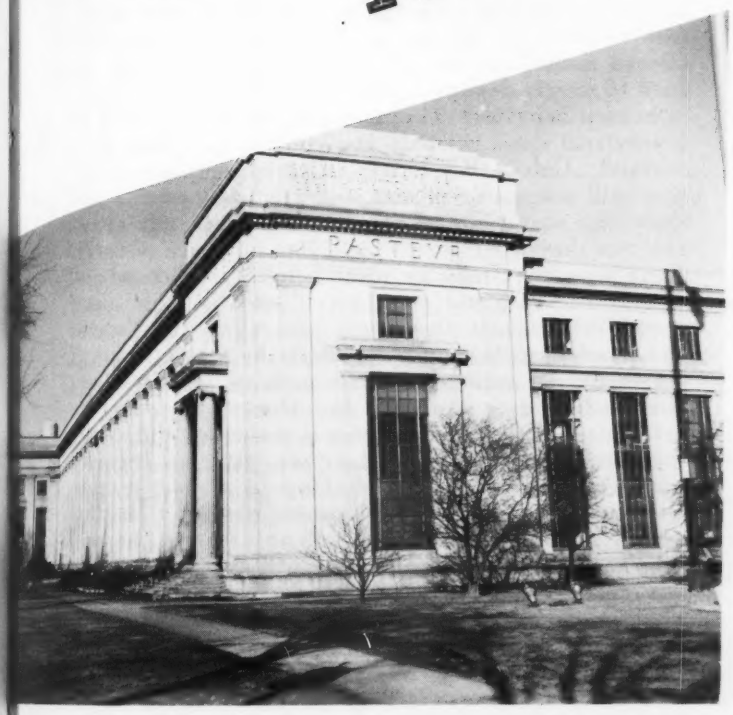
Apparatus in use at the M. I. T. cavitation laboratory for producing cavitation erosion in a metal sample Dan Sully



Touch football games were played amongst the various living groups on the Tech athletic fields while nearby work was begun on the new Senior House.

NIGHT AND DAY

There are some light moments at Fraternity parties where, along with the usual dancing, a floor show is usually featured.



Long nights of study are nothing new, but with a theme nearly due, the nights become longer and longer.

Worker Relationships

Some Effects of Certain Social Factors on Rate of Work

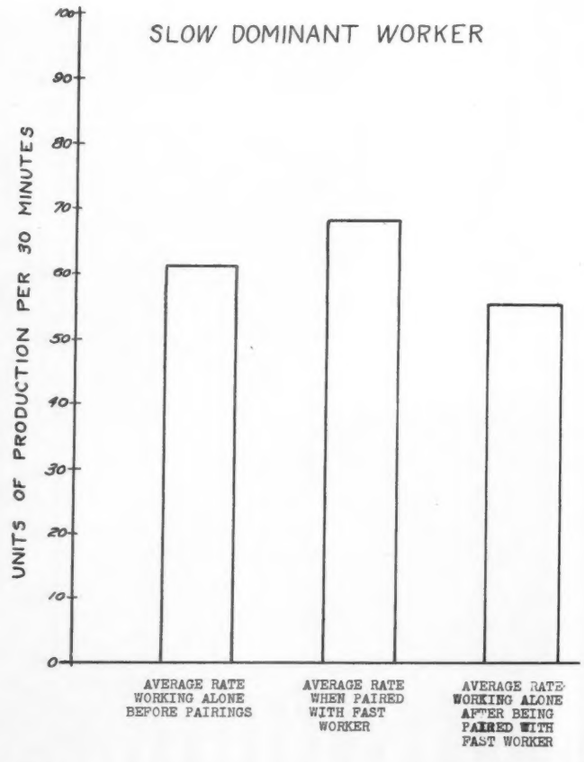
By ALEX BAVELAS

Industrial Relations Section, Massachusetts Institute of Technology

IT is a widely accepted notion that the rate at which an individual works is affected by the performance and attitude of his fellow workers. It is generally assumed also that in almost every work group there is at least one individual who acts as pace-setter. It is not difficult to find an industrial manager who can point with confidence to fluctuations in output which he feels are the result of social and psychological factors. It is very difficult, however, to find the manager who can support his belief with any specific knowledge on how this general effect takes place.

This is not a criticism of the manager. His primary job is not the scientific investigation of psychological problems in industry. Criticism may be directed, however, to what appears to be an apathetic and incurious attitude toward the problem itself. There seems to be a feeling quite prevalent among managers that the problems in human behavior are not approachable with the logical tools that are so successful in solving technological problems. There seems to be a willingness to proceed, although with dissatisfaction, with concepts about human behavior whose vagueness would be considered intolerable in the areas of technology and engineering. All of this does not mean that the manager in the factory should become actively engaged in psychological research. In the usual industrial setting it is seldom feasible to create conditions which will permit the variation of factors and the opportunities for measurement that are necessary. But it does mean that the manager should be ready to examine research results in this field with the same attention and readiness to put them to use as is evident in his attitude toward findings in the physical sciences. It does no good to merely deplore the backward state of the study of human behavior. The managers of industry will in a very real sense get only the kind of help that they demand. Unless they create an active demand for it, they will not only continue to remain unaware of the knowledge about human behavior that is already available but they will lose any chance to influence research along lines that may be most helpful to themselves. The manager should press social scientists for more specific statements than such generalities as "social and psychological conditions affect the rate of work." He should be asking questions such as "What determines whether a slow or a fast worker becomes the pace-setter of the group? Does it make any difference with respect to the effect of a pace-setter on a group whether the workers are working in a co-operative setting or just working in the same room? If a slow and a fast worker are paired off on a job, what will determine whether the slow one will speed up or the fast one slow down? And, whichever effect occurs, what can be said about the magnitude of that effect?"

Figure 1



Are valid experiments to answer such questions possible? Suppose such an experimental approach were to be planned, how would one proceed? Let us take the question: "If a slow and a fast worker are paired off on a job, what will determine whether the slow one speeds up or the fast one slows down?" Can this question be stated in a way that permits answering it experimentally? The question in its present form leaves many points unclear. For instance, how shall *fast* and *slow* worker be defined? Under what conditions does one measure the rate which determines the initial fastness or slowness of the individuals before they are combined in pairs? Should we have our subjects work completely alone until they gravitate to a stable rate of work? Will they, as a matter of fact, settle down of themselves to a more or less constant rate of output? How many subjects will we have to start with in order to find some that are naturally settled down to rates of work sufficiently different to be labeled fast and slow.

These are only a few of the questions which would have to be answered before the experimental pattern could be constructed. They are not particularly new problems for the experimental psychologist and not especially difficult ones. Let us skip over the detailed manner in which they would be solved and look at what the experiment itself might look like. It might run along these lines:

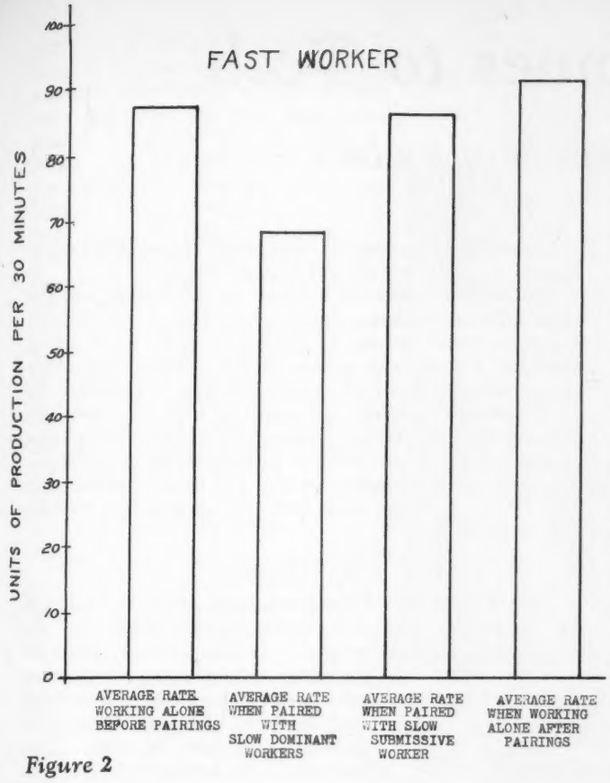


Figure 2

1. It would be arranged to have a number of people doing a simple, repetitive job that could easily be timed, and whose method could be kept virtually constant.
2. Each subject would work alone until his rate of work stabilized within certain statistical measures.
3. From the above group would be selected *fast* and *slow* workers, categories being set up in terms of statistically significant differences in rate of work.
4. Among the slow workers would be selected some subjects who were aggressively dominant in social situations, and some who were mild and submissive in the same situations.
5. Subjects of both types from the slow group would be paired with fast subjects.
6. Subjects who had worked in pairings would also work intermittently alone so that the effects of the pairing might be studied out of the pair situation.

Actually this hypothetical experiment is essentially identical with one already done under laboratory conditions. Although this experiment was a pilot study intended primarily for the purpose of developing a method for doing experiments on this problem, the findings are interesting and appear to have some possibility of applications in certain industrial situations. Figures 1, 2 and 3 summarize the results with respect to the variable *rate of work* (units produced per 30-minute periods). It may be readily seen that although the *slow dominant* and the *slow submissive* subjects individually gravitated to a very nearly equal rate of work, they were affected quite differently by being paired with fast subjects. While the slow dominant subjects increased their rate, their increase was in the neighborhood of eight per cent as compared with an increase of 36 per cent for the slow submissive subjects under the same conditions. A more striking difference is seen in the rate of work by the individuals in the dominant and submissive groups when they worked alone *after* the pairings with the fast workers. The slow dominant subjects worked at a rate of 10 per cent *less* than their initial rate of work when working alone. The slow submissive subjects worked at a rate of 46 per cent *more* than their initial rate of work when working alone.

Two other findings are of interest. The slow dominant workers tended to talk freely about the job situation whereas the slow submissive workers if they talked at all with their partner talked about things having nothing to do with the work situation. The conversation of the slow dominant workers invariably included these ideas:

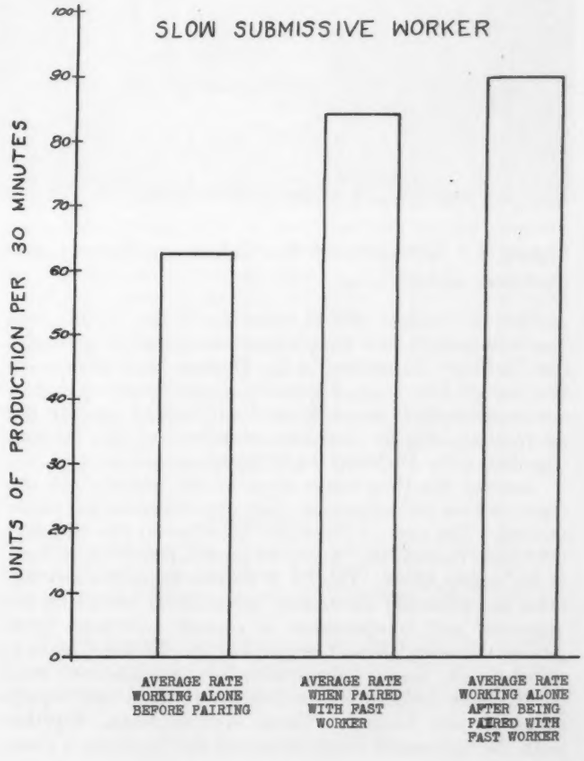
1. The fast worker was working too fast.
2. He (the slow dominant worker) was working fast enough.
3. He (the slow dominant worker) would certainly not speed up and try to keep up with the fast worker.

Note that in spite of the frame of mind revealed by the conversation that the slow dominant workers did increase their rate of work. Interviews after the experiment was over indicated that the slow dominant workers uniformly believed that they had not changed their rate of work in the paired situation.

Another interesting fact is that accidents or errors which necessitated pauses or rearrangements of the work and therefore reduced the average rate increased for the slow dominant group when they worked in the paired situation, and increased again markedly when they worked alone following the paired situations. As a matter of fact it is these delays more than any other single cause which result in the outstanding decrease of the rate of work in the solitary situation following the paired situation for the slow dominant workers. It is extremely doubtful that these accidents or errors were intentional. It appears that they were due to decreased attention, careless handling of materials and lowered motivation for the job.

(*Continued on page 134*)

Figure 3



Television Comes to Tech

By THE M. I. T. TELEVISION SOCIETY

IN 1909, when radio was first being developed, a group of M. I. T. students formed the first collegiate amateur radio club in the country. Last year, M. I. T. again was the leader in a new field — television.

During the summer term of 1947, a group of electrical engineering students from the co-operative course VI-A became interested in television as a result of their work in industry while on their plant assignments. Near the end of the term, plans were formulated for the creation of a student organization to keep abreast of the latest developments in television. The result of these plans has been the M. I. T. Television Society, the first organization of its type in the country.

To promote interest in television, the Society has initiated a series of lectures and movies on the various technical aspects of the subject. A library of books, periodicals, and pamphlets pertinent to television is also being compiled.

Television Society

Figure 1. Members of the Television Society working with DuMont technicians

One of the first official activities of the Society was its participation in a television demonstration given by the DuMont Laboratories for Boston businessmen on October 22 last year. Members of the Society aided in the program that was televised and helped operate the equipment. Figure 1 shows members of the Society together with DuMont technicians in action.

Among the long-range aims of the Society are the construction and operation of an experimental television station. The cost of construction of even the simplest television transmitter would be prohibitive for a student group acting alone. The M. I. T. Television Society has been exceptionally fortunate, however, in obtaining the approval and co-operation of several television companies. Among these companies, the Philco Corporation and the Radio Corporation of America have been particularly helpful in contributing tubes and equipment to the Society. These contributions, together with the full use of the facilities of the Institute's Communications Department, have made it possible for the Society to make considerable progress.

To facilitate efficient activity in the building of the transmitting station, the project has been divided among several groups of students, with each group handling a particular phase of the construction. One group will construct the audio generator; another, the audio amplifier; while yet another will construct the video generator. Other groups will handle other phases of the work. Each division is headed by a manager, who will be responsible to the technical director and will select or design with him the appropriate circuits and materials.

Video Generating

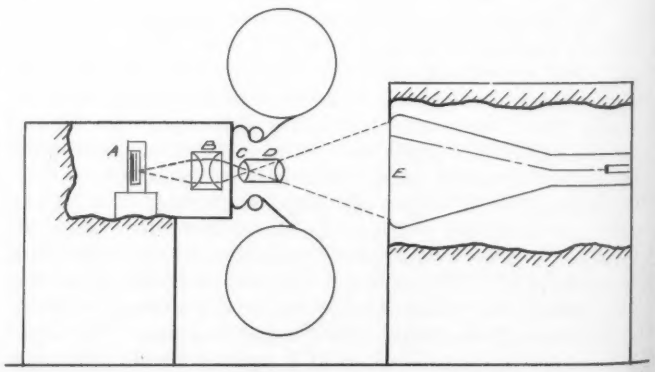
The task of the video generating group is to design and construct camera and test signal equipment. At the present time the group's schedule includes plans for building two pick-up devices, a monoscope test pattern generator and a flying spot scanner. Although cameras of the "live pick-up" type are highly desirable, no immediate plans for building this type of equipment have been formulated because of the prohibitive costs which would be involved in obtaining the necessary image orthicon tubes.

The monoscope generator now under construction will employ an RCA type 2F21 tube and will generate a signal to be used for test purposes. This generator is being constructed in four major parts; the scanning system, video amplifier, monoscope, and high voltage supply. At the present time final construction details are still being correlated.

The flying spot scanner will be used primarily for photographic slide and movie film pick-up. It is of interest to note that the

Figure 3. The main parts of the modern flying spot scanner being built by the Television Society

Television Society



principle of "flying spot scanning" is again coming back into common practice after many years of disuse. Actually, the very first successful television system used a flying spot scanner in the video generator. The system, using the Nipkow disk, was entirely mechanical and extremely cumbersome and limited in its application. Figure 2 shows a typical early installation.

Today it is possible to dispense with the mechanical features of the old flying spot scanner and make it completely electronic in operation. This is due almost wholly to the new, intensely bright cathode ray tubes now available.

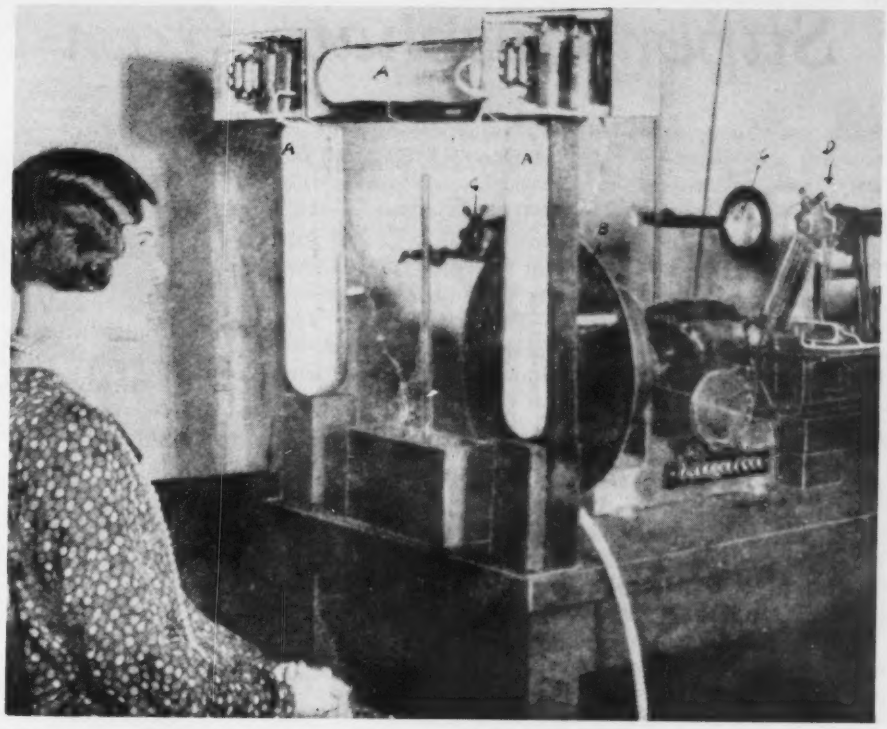


Figure 2. The old mechanical scanning apparatus originally used in television

Television Society

Optical Principles

Figure 3 shows the principal parts of the modern flying spot scanner now under construction by the video generating group.

At the left is a standard motion picture projector which throws a three- by four-inch picture on the surface of a special five-inch flat-faced cathode ray tube. At the same time, this tube is operated so that a complete 525 line interlaced raster is produced on its face, in this same three- by four-inch area. After the set-up has been firmly arranged and the lenses critically focused, the projector lamp is removed and replaced by the phototube, *A*, in figure 3.

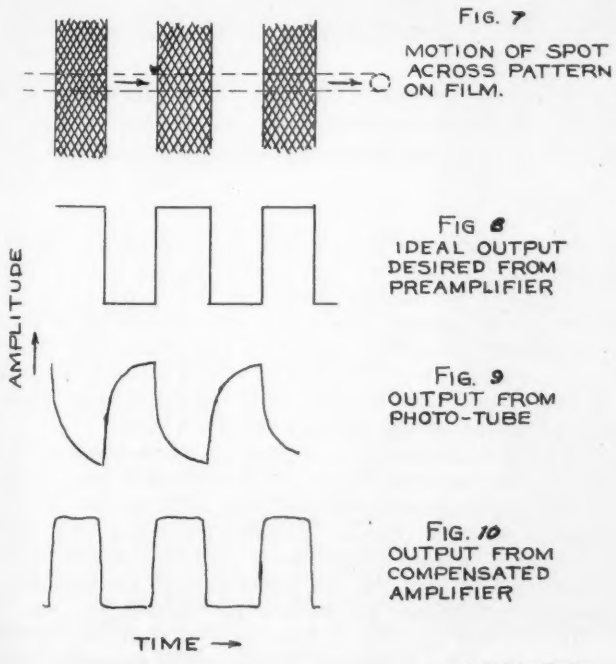
With this slight modification the whole system has really been reversed so that the light now originates at the face of the cathode ray tube and is collected at the phototube, where the projection lamp was before the replacement operation. This is possible since the direction of light through the optical system makes no difference.

When the flying spot scanner is in operation, the face of the cathode ray tube, *E*, appears to the eye as a white, luminous screen. An image of this raster is focused by the projection lens, *D*, onto the film gate, *C*, of the projector. The light passes through the film and is focused by condensers, *B*, on the phototube.

Of course, what appears as a white, luminous raster is really the result of an intensely bright spot moving rapidly across the surface of the tube. As the spot moves across the raster, an image of the spot likewise moves across the transparent motion picture film in the gate. The image on the film modifies this ray of light as it passes through the film to the phototube. That is, at any instant, the intensity of the light at the phototube will be determined by the density of the photographic image at the particular point where the "flying spot" happens to be.

The phototube, an electron-multiplier type which produces tremendous amplification of the signal, transmits this information to the receiving set by conventional television means, and the picture is reproduced by the receiver's viewing tube.

Each frame of the film is held in place long enough to be scanned completely. Then, while the "flying spot" is retracing to the top of the raster to start again, the next motion picture frame is moved into position. By continuing this process, there are seen on the viewing tube thirty complete still pictures every second, which the eye blends into an illusion just as with the conventional motion pictures.



Television Society

Amplifier Circuit

The circuit of the amplifier, which is of the conventional video type utilizing a 6AK5 input tube and a 6J6 cathode follower output tube feeding into a coaxial cable.

The light-emissive characteristics of the flying-spot kinescope present some difficulties in this type of video generation. This problem can best be explained by an example.

(*Continued on page 128*)

Superphosphate from the TVA

By EDWARD A. MULLERY, '48

THE public power and flood control aspects of the Tennessee Valley Authority have obscured several other important phases of the TVA's activities. It is not generally recognized, for instance, that TVA has done considerable work in chemical engineering, work which has done much to improve the welfare of the people of the valley.

It will be recalled, however, that the original nucleus of the TVA was the government installation at Muscle Shoals, Alabama, consisting of a dam, a hydroelectric plant, and two nitrate plants, all built during the first World War as part of our munitions program. Thus, from its birth in 1933, the Tennessee Valley Authority was in the chemical business.

When the nitrate plants were built, in 1917–1918, it was assumed that after the war they could be used to produce nitrates for fertilizer purposes. But TVA engineers quickly realized that such a program would be futile. Nitrate Plant No. 1, designed to produce ammonia by direct synthesis, was the first plant of this sort to be built outside of Germany. Insufficient information and experience were available at the time it was designed, and attempts to operate it in 1918 were unsuccessful. By 1933, this plant was totally and hopelessly obsolete.

Nitrate Plant No. 2 used the calcium cyanamide process to fix nitrogen, the cyanamide subsequently being converted to ammonium nitrate. This plant could have been put into operation, but only with the expenditure of a great deal of money; and once it was in operation, there would have been no assurance that a market could be found for the product.

Inasmuch as the TVA Act had specified that the Muscle Shoals plants were to be used for fertilizer production, and since the production of nitrogenous fertilizers was out of the question, the TVA administrators began considering the various other possibilities. A small part of the nitrate plants could have been used for the production of potash; but private industry in this field had already developed to such an extent as to make such a program of doubtful value.

Phosphate fertilizer represented a third alternative, and one which offered every advantage. There had been some research carried out, both in Europe and in this country, on production of different types of phosphates for agricultural use, but the lack of important changes in the industry was in striking contrast to the development in recent years of the production of nitrates and potash. Industry was producing superphosphate ($CaH_4(PO_4)_2$) in small quantities, but there appeared to be an ample field in which to improve and cheapen phosphatic fertilizer and establish new fertilizer practices, as specified in the TVA Act.

TVA

Applying phosphate and lime to the pastures of one of the farms operating under the TVA program for test-demonstration of fertilizer practices

Drying ammonium nitrate to be used for fertilizer, the last stage of manufacture TVA

A further advantage in a program of phosphate production was the occurrence of natural rock phosphate deposits in Tennessee within eighty miles of the nitrate plants at Muscle Shoals. Finally, the equipment and facilities at Nitrate Plant No. 2 could be utilized to a considerable extent for the production of concentrated phosphatic fertilizer by the electric furnace process.

In the fall of 1933 it was decided that the initial units of the TVA Fertilizer Works would consist of two

TVA

Electric phosphate furnace in operation in the TVA chemical plant at Muscle Shoals, Alabama

temperature in the furnaces rises to between 1300° and 1400° C. The following reactions take place.

$$Ca_3(PO_4)_2 + 3SiO_2 \rightarrow 3\ CaSiO_3 + P_2O_5$$
$$2P_2O_5 + 10C \rightarrow 10CO + P_4(g)$$

Phosphorus vapor and carbon monoxide are drawn off the top of the furnaces. One furnace is provided with a combustion chamber in which the phosphorus-carbon monoxide mixture is immediately burned with air; the P_2O_5 and CO_2 resulting are then passed to a hydrating chamber where phosphoric acid is made by contact with a water spray. In the other three furnaces, the furnace gas is passed into a condenser, where the phosphorus is condensed and separated from the carbon monoxide. The condensed phosphorus is stored under water and is later pumped to combustion chambers, where it is burned to P_2O_5, which is then hydrated to form phosphoric acid. The carbon monoxide which is obtained from the furnaces equipped with condensers is used as a fuel in the agglomerating kilns.

Two types of fertilizer are prepared from the phosphorus produced in the electric furnaces. The first of these is superphosphate, which is prepared by mixing the proper proportions of 72 to 78 per cent phosphoric acid and finely ground phosphate rock. A simplified equation of the reaction would be:

$$Ca_3(PO_4)_2 + 4H_3PO_4 \rightarrow 3CaH_4(PO_4)_2$$

(*Continued on page 128*)

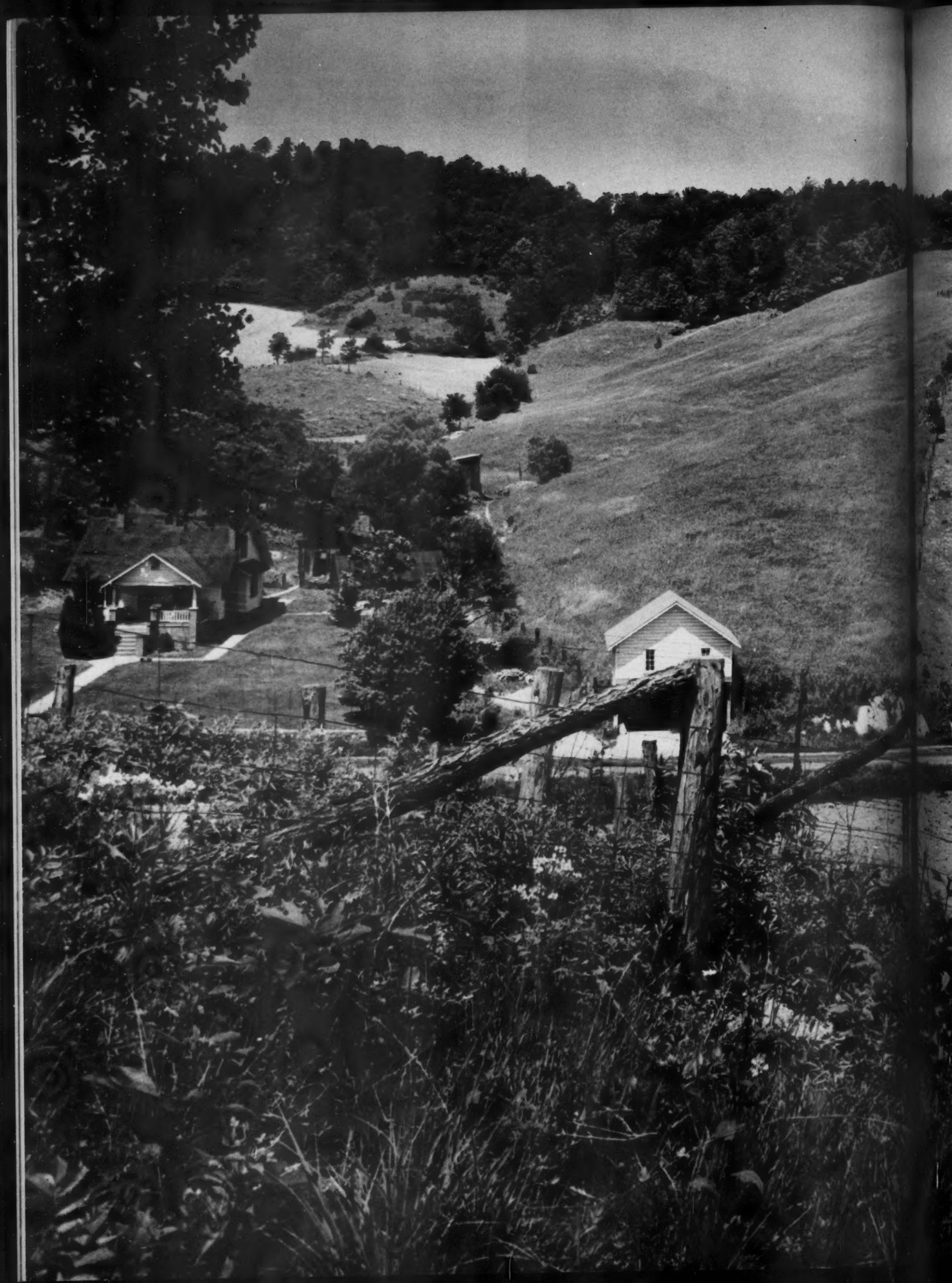
electric smelting furnaces with all auxiliary equipment for the production of concentrated superphosphate. These two furnaces were built during 1934, a third furnace was added in 1937, and a fourth in 1939. Two plants have also been built to produce calcium metaphosphate ($CaPO_3$).

The first step in the production of phosphates is the mining of the phosphate rock. Tennessee phosphates usually occur in beds six to eight feet thick and are in a mineral form which may be represented as $Ca_3(PO_4)_2$, although the actual structure of the mineral is somewhat more complex. Some of the rock is used in the electric furnaces without further treatment, but the lower grades are first washed to remove impurities, thereby increasing the percentage of phosphorus.

Since the electric furnace requires its charge to be in a lump form, very finely divided rock cannot be used directly, but must be agglomerated. This is accomplished by heating the finer grades to the melting point in rotary lime kilns. Fusion of the rock is allowed to progress just far enough so that the proper lump size is obtained.

The lump phosphate is mixed with the proper proportions of silica and coke and passed into the furnaces. Each of the four furnaces has three carbon electrodes 30 inches in diameter, and draws about 6,000 kilowatts. Under the influence of the electricity, the

TVA



Phosphate and lime applied to the left-hand slope of this hill have reclaimed it from a waste similar to the right-hand slope
TVA

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From the Editor's Notebook

Last November **Werner Gumpertz** strolled into the *T. E. N.* office and amazed us with a fluent and authoritative discussion of bridge construction. When he asked if he could write an article for us on the Kaempfelbach Bridge, we took Werner under our wing and told him to go to work on it. Werner attended the Swiss Federal Institute of Technology from 1935 to 1939. After working in the Netherlands for a year, he came to the United States, and was employed here as a civilian until 1943, at which time he entered the United States Army, Corps of Engineers. His last job in the Army, before coming to M. I. T. this fall, was that of Structural Engineer, Office of the Chief Engineer, European Command, United States Army. In this position he supervised Army Engineer construction activities dealing with hospitals, depots, roads, training centers, war crimes enclosures, and bridges.

Another newcomer in *T. E. N.* circles is **Ken Kopple,** who only last October registered as a Freshman here at M. I. T. Since that time he has found time to write two articles for us. The first, on "Tagged Molecules," appeared in the December issue, while his article "Cavitation" appears in this one. Ken was graduated from the Cheltenham High School in Elkins Park, Pennsylvania, with two major prizes in his hand to help him with college. One was as one of the forty winners in the Westinghouse Science Talent Search and the other was a Certificate of Merit in the Pepsi-Cola Scholarship Program. Ken seems to be wedded to the study of chemistry now.

This month **Professor Alex Bavelas** has written on a subject on which he has been working for many years. Professor Bavelas received his B.S. at Springfield College and then went on to get his M.A. at the State University of Iowa. Back in March 1944 he came to Tech as an instructor, and since then he has become an assistant professor of psychology in the Department of Economics. Professor Bavelas has achieved special renown among *T. E. N.* staff members for his very interesting approach to courses in psychology and labor relations.

There is no one really on the *T.E. N.* staff who does not know **Ed Mullery,** for his is a familiar face around the office. He can rightly claim to be an old-timer, though his interest and ability are what earned him the title of Advertising Manager. Ed, a veteran from Omaha, Nebraska, spent thirty-two months in the Army, mostly in the Signal Corps, before he was able to return to Tech and follow his study of chemical engineering. Now a senior, Ed is quite interested in the work of the TVA and possible applications of a similar plan to the Missouri Valley.

The Dragon's Den

A Pause for Reflection . . .

There are many things which men can not physically do and neither shouts nor lamentations will ever enable them to change this fact. At times hard work plus hard thinking have enabled men to accomplish what was hitherto thought impossible. Engineers well realize that by their efforts, people today do what a century ago they would not have dreamed of trying. In the field of transportation alone such steps have been made that we now make trips in a few days which our grandparents, if they were bold enough, would have expected only to make in months. Physical limitations are removed only by thought, work, and one other very important factor — time. No amount of thought and work could have built up the railroad system in the United States in one week. Progress in the engineering fields is always dependent on previous progress. Thorough planning and deep thinking can reduce the time taken in freeing men from any physical limitations, but the time factor is still vitally important.

Just as the solution to plain physical problems is found by the engineer in a thoughtful, non-emotional attack, so we all must work the same way in overcoming social and economic limitations. Of course, with society in general as with the engineer in particular, there must be a certain amount of wishful thinking and forward looking. Philosophers and dreamers are needed to point out what social conditions ought to be changed. However, once we have decided where we wish to go, we could do well to use the engineering approach in changing social and economic realities. Concrete and practical thinking along with sufficient time are the best and probably the only ways to alter society. History shows that attacks which were both radical and aggressive often caused more trouble than they ever overcame and seldom accomplished what was originally envisioned.

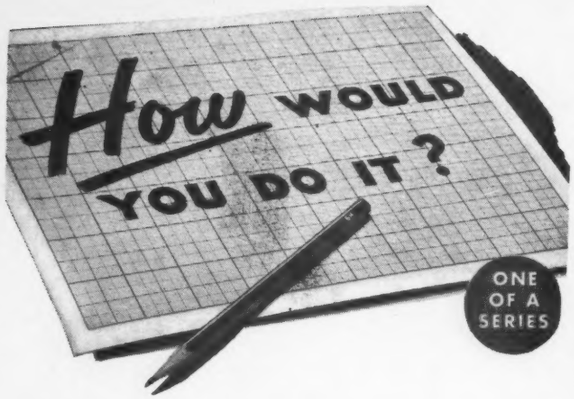
The oppressed man and the spokesman for the oppressed man, always shouting about various human rights, so often reminds one of the child who screams when denied something. All the howling in the world will not enable the child to do something which, at the time, he is physically unable to do. While some parents may give in to a screaming child, most insist on a more intelligent approach before they allow the child to decide things for himself.

The concept of human rights could probably be re-examined to great advantage, but let us leave that for future philosophers and consider only actualities. Some things are denied all of us, rich and poor of all races in all countries. It may seem that more valuable things are denied some people than are denied others. In so much as this is true, the intelligent adult attitude recognizes such conditions as being facts. It is for the philosopher to show why matters stand as they do and why they should be different. Human rights will undoubtedly be used as an argument in favor of changing social conditions. The pessimist feels that it is useless to attempt to carry out what the philosopher recommends and that any effort along such lines is wasted. If we optimistically accept the philosopher's advice that social conditions should be changed, we must still recognize the reality of a status quo. Revamping society and in any way altering the status quo can not be done by decree. If it is to be done at all, time must be allowed. From previous experiences both with changing social and physical realities, we might surmise that the less time we allow, the less satisfied we shall be with our results.

Some one may say that blind men have as much right to see as men with good eyesight. Though we believe that they do, the fact remains that the men are blind. If we feel seriously enough that the blind men ought to be permitted to see, then we take steps to overcome the physical limitations that have been placed on such men by scientifically attacking the problem of blindness. Here action and time are more important than words.

At M. I. T., we students should realize the importance of ideas and make an attempt to consider the philosophers' suggestions. However, we should realize the difference between the dreamer who points the way and those who try to follow along the way. The latter to succeed must remain as practical in their social and economic thinking as the successful engineer is in his professional thinking.

E. T. M.



PROBLEM — Your company manufactures gas burners of varying number and spacing of gas ports. You want to develop a drilling machine which can be changed over with a minimum of time and effort to drill the holes in the different burner castings. How would you do it?

THE SIMPLE ANSWER — The illustration shows how one manufacturer solved this problem by using S.S.White flexible shafts as spindles. This arrangement makes possible quick changes of spindle groupings to meet different requirements. As here, S.S.White flexible shafts make ideal power drives for almost any machine part which must be adjustable.

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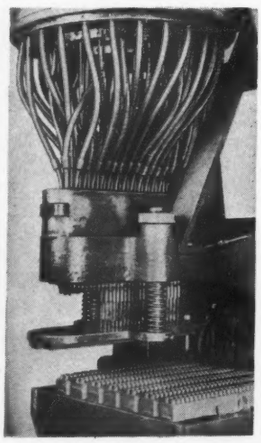

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Capt. S. C. Gawlowicz, C. E., M.I.T., '31

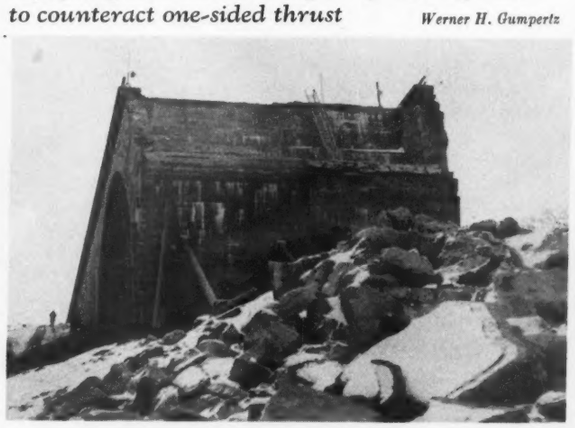
THE KAEMPFELBACH BRIDGE

(*Continued from page 109*)

included a cantilever catwalk 3 feet, 3 inches wide on each side and a roadway 24 feet, 7 inches wide. After the concrete slabs were secured to the structure, the bridge was opened to traffic and has well served the heavy military and civilian requirements ever since.

As pointed out above, there is one weak point in the bridge structure as it stands now. This weak point lies in the "tie-back" cables which counteract the one-sided thrust of the concrete arches. Normal temperature variations can be expected to cause comparatively important changes in the cable length. An elongation of the cables might cause the whole concrete structure to fall beyond its elastic limit, thus causing cracks reducing the value of the cables considerably. Some minor influence could also be expected from moving and impact loads and from the plastic flow in the concrete. Finally, the cables are close to the ground and therefore exposed to sabotage and tampering.

Left foreground shows temporary shoring used to counteract one-sided thrust *Werner H. Gumpertz*



Past experience with a problem of such special nature is of course very limited. No similar case in American bridge engineering could be found by the writer of this article. However, Swiss engineers had been faced with very similar problems some time ago. Their solution has since fully proven itself, and it seemed so applicable here that its adoption was recommended for the present case. (*Continued on page 124*)

What kind of engineer does the Telephone Business need?

Many kinds, for many kinds of work . . . research and development, technical and economic planning, operations, which involve manufacturing, construction and maintenance of telephone facilities.

Telephone engineering is broad in scope but includes intensive study of a wide variety of specific problems. Much of it requires the special knowledge of electrical, mechanical, industrial or other engineers. All of it requires the engineer's background, his understanding of scientific principles, his trait of weighing facts and deriving logical and workable conclusions.

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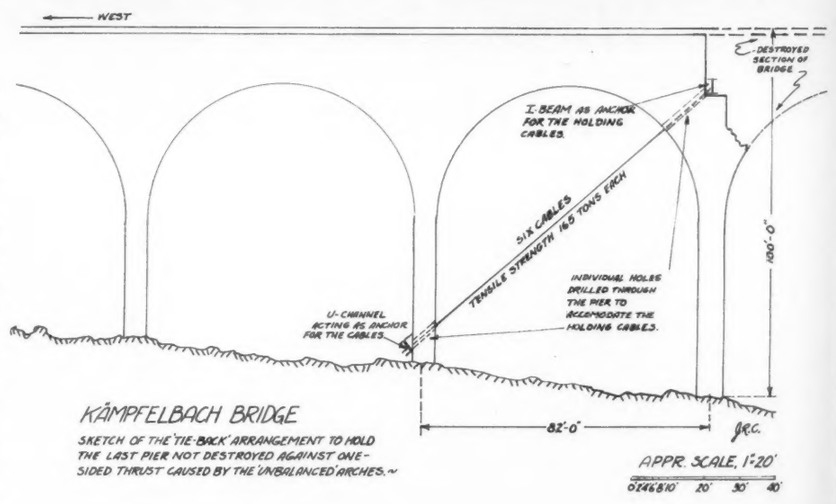
KAEMPFELBACH BRIDGE

(*Continued from page 122*)

Reference is made to two articles in the *Schweizerische Bauzeitung* (Zurich), the first in Volume 79 (1922), No. 11, the second in Volume 83 (1924), No. 25 and 26. Here it was not a case of destruction of the center part of a concrete viaduct. A gap had been left between the two masonry arch approaches and the center structure consisted of a simple steel truss.

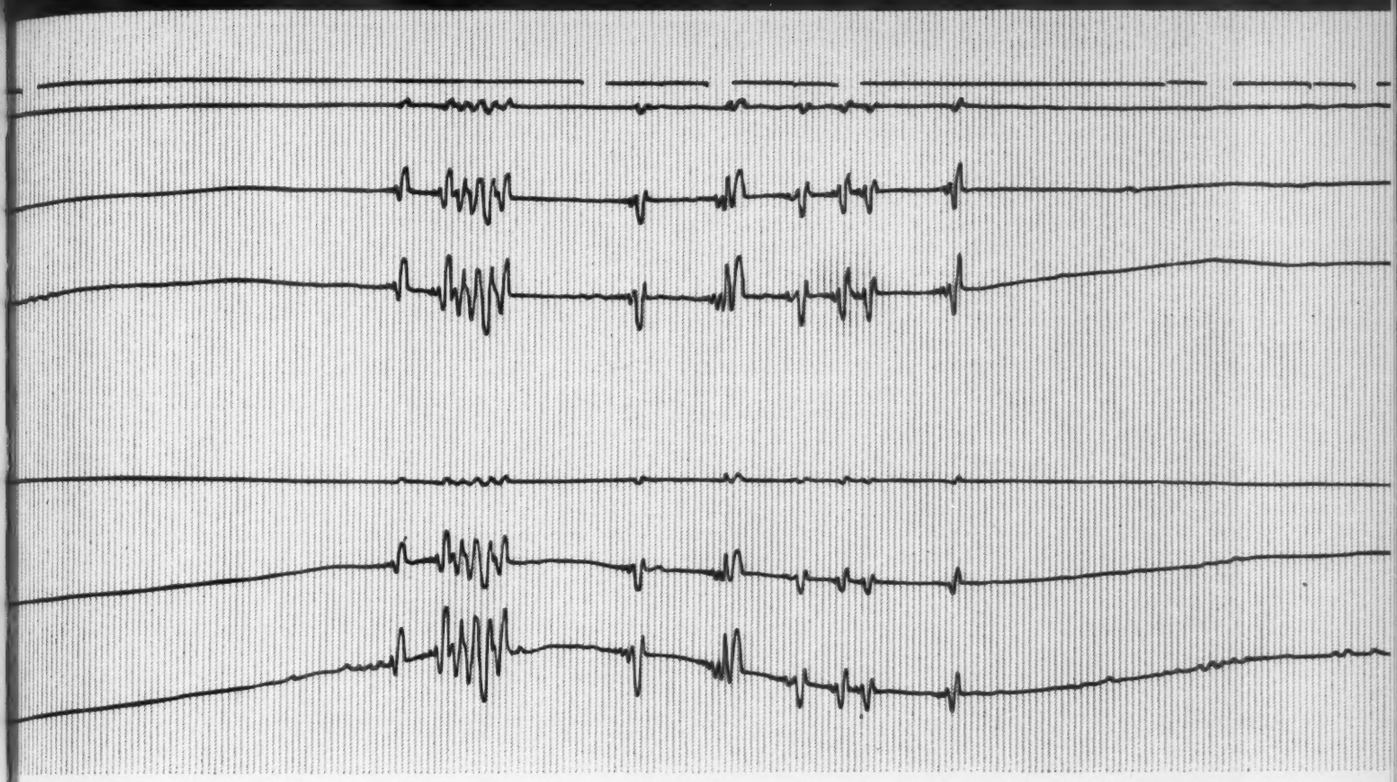
Professor M. Ros of the Swiss Federal Institute of Technology in Zurich has written the second article mentioned above. The article deals with the Sitter River Viaduct of the Bodensee-Toggenburg Railway in Switzerland. The piers of the stone structure are up to 330 feet high and the center steel span connecting the two river piers is 400 feet long. Since the erection of the bridge in 1909 the one-sided thrust had caused a considerable deflection of the two river piers, amounting to 11 inches in 1921. At this time, the phenomena of plastic flow were not too well known, but excessive test measurements gave a good picture of the manner in which the structure reacted, including the considerable downward deflection of the arch crowns and the appearance of cracks in the arches. Since the steel truss was supported by bearings as a simple beam, it did not help to counteract the thrust from both sides.


WEST
DESTROYED SECTION OF BRIDGE
I. BEAM AS ANCHOR FOR THE HOLDING CABLES.
SIX CABLES TENSILE STRENGTH 160 TONS EACH
INDIVIDUAL HOLES DRILLED THROUGH THE PIER TO ACCOMODATE THE HOLDING CABLES.
U-CHANNEL ACTING AS ANCHOR FOR THE CABLES.
100'-0"
82'-0"
KÄMPFELBACH BRIDGE
SKETCH OF THE 'TIE-BACK' ARRANGEMENT TO HOLD THE LAST PIER NOT DESTROYED AGAINST ONE-SIDED THRUST CAUSED BY THE UNBALANCED ARCHES.
APPR. SCALE, 1"-20'
0 2 4 6 8 10' 20' 30' 40'

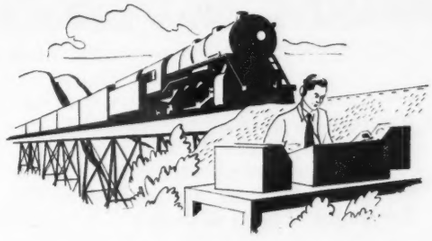
James Cowdery

It was therefore decided to create an artificial counter thrust and to transmit this thrust axially through the steel truss in both directions — a solution both ingenious and simple. This was accomplished by installing a counter thrust lever at the roller bearing end of the steel span, using the common leverage principle. The free arm of this lever was counterbalanced by steel weights, and the other arm had two stiffly connected levers, one of which rested against the arch structure, the other transmitting the counter thrust into the steel

(*Continued on page 126*)



Picture of a bridge groaning under load...



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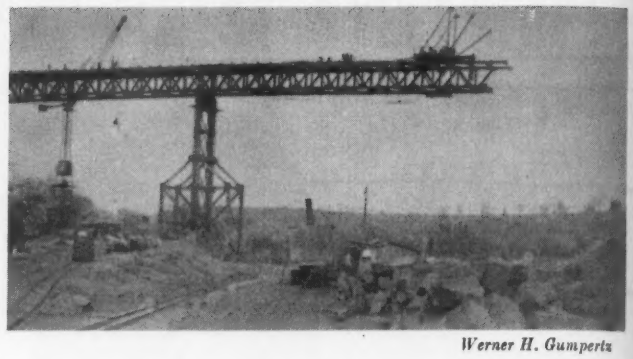
THE KAEMPFELBACH BRIDGE

(*Continued from page 124*)

truss and eventually through the rails and a special horizontal bearing into the other end of the arch structure. As one arm of the lever was freely suspended, any change in the length of the steel truss could be absorbed by a slight upward or downward movement of this arm. No change in the magnitude of the horizontal counter thrust would be caused by this motion. Temperature changes, traffic and impact loads, as well as changes in the masonry arches, could thus be easily absorbed. No adjustment was necessary, and the lever was far removed from any possible interference.

The counter thrust was initially set at 250 tons, and increase or decrease could be effected simply by adding or removing weight from the free arm of the counter thrust lever. Actually, the thrust force of 250 tons proved to be of proper magnitude, and in the year following the installation of the counter thrust lever, the original deflection of the high stone piers was reduced considerably. The cracks in the arches were grouted and the entire structure is now completely sound and, with the continued use of the lever, needs no further adjustment.

In applying the above principle of a counter thrust lever in the case of the Kaempfelbach viaduct, it should be noted that most conditions are very similar in both cases. The magnitude of the necessary counter thrust could be estimated at first to be in the neighborhood of 200 tons. Later adjustments could be made when measurements showed whether the original deflection had been reversed. However, the steel span of the German bridge is longer — 672 feet — and a rough calculation should be made to insure the safety of the structure against buckling when an axial pressure of 200 tons is applied.



Werner H. Gumpertz

Derricks about to erect the last pier. Note the considerable deflection of the truss being used as a cantilever

For the purpose of this approximate computation, the whole steel span is considered a column axially loaded with both ends unrestrained. The weight of the span itself would prevent upward buckling, while downward buckling would be prevented by the three intermediate piers. Between these piers the bridge is designed for the safe absorption of the bending moments downward. Therefore, only sideways buckling will be considered. Using the Euler column formula:

$P = \frac{n^2 \pi^2 EI}{cL^2}$, in which

P = maximum allowable pressure (thrust)

n = 1 (because both ends are unrestrained)

E = modulus of elasticity of steel

I = moment of inertia of the weakest cross section of the structure about the vertical axis

c = factor of safety, assumed to be $2\frac{1}{2}$

L = length of span in inches (*Continued p. 132*)

The Sitter River Viaduct in Switzerland

Schweizerische Bauzeitung

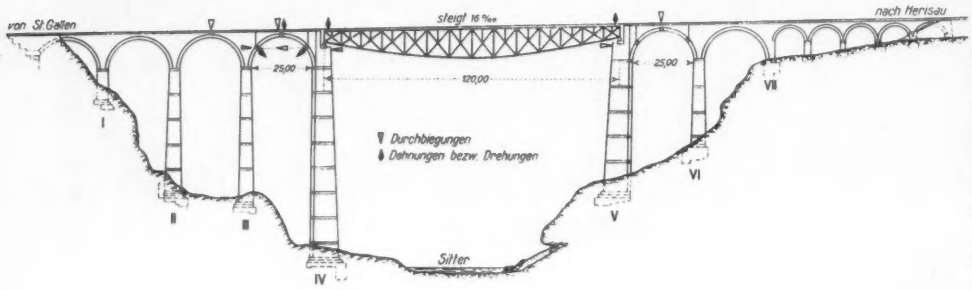
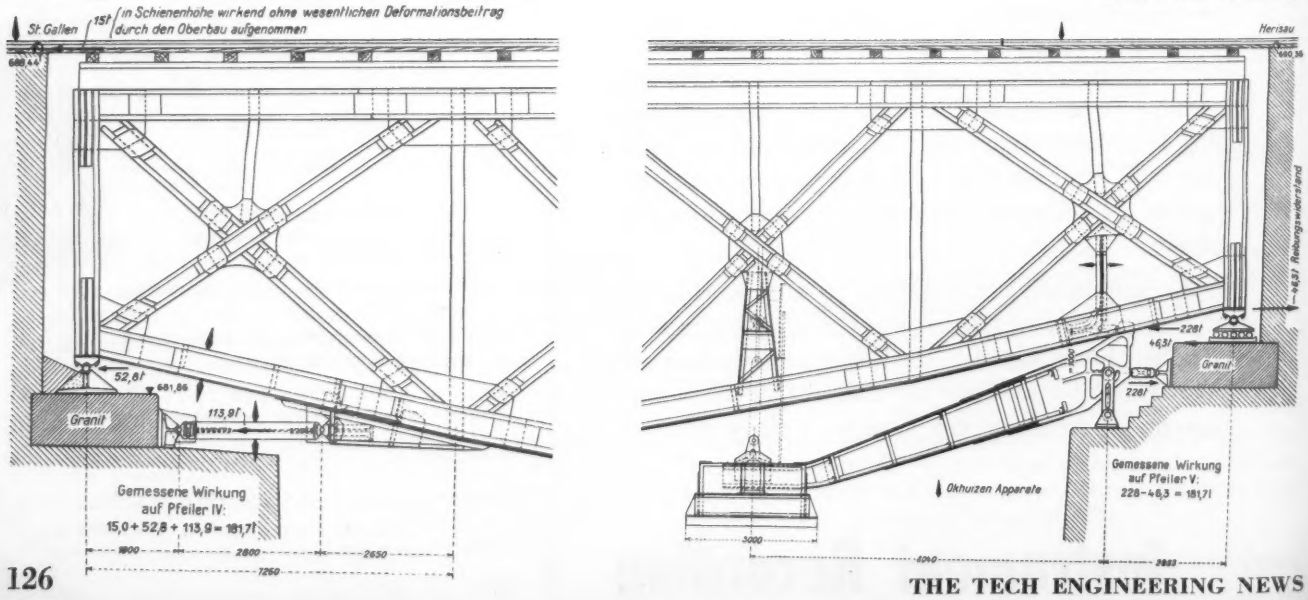


Diagram of the two ends of the steel span of the Sitter River Viaduct, showing the counter-thrust lever installed

Schweizerische Bauzeitung



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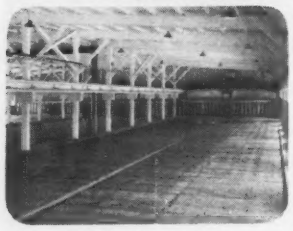
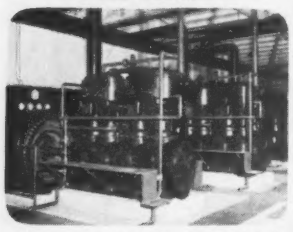


Group Lift Saves Labor on Ice Tanks



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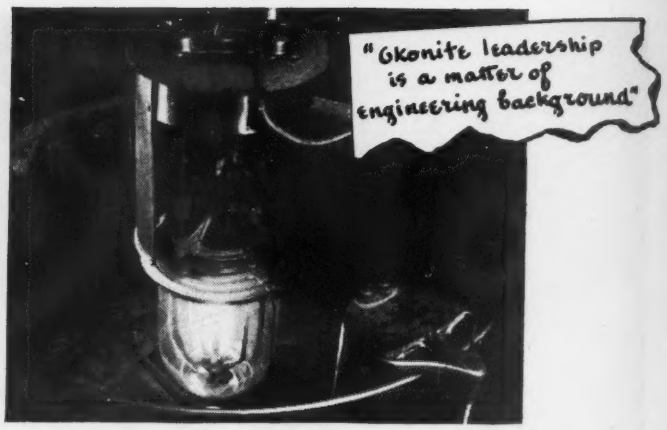

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insulated wires and cables

TELEVISION COMES TO TECH

(*Continued from page 115*)

Suppose that a black and white picture having a striped pattern, such as in figure 7, is being televised. The *ideal* voltage output of the phototube, as viewed on an oscilloscope, would appear as shown in figure 8. However, if one viewed the *actual* signal existing at the output of the phototube, one would see a wave form as indicated in figure 9. There it can be seen that the leading and trailing edges of the wave are not vertical as they should be, but appreciably rounded and distorted. This phenomenon is caused by the brightness decay characteristics of the phosphor screen on the flying spot kinescope. Thus the flying spot actually consists of an intensely bright head and an exponentially decaying comet-like tail. Because of the difficulty in completely eliminating this phenomenon, some means of compensation must be employed in the preamplifier itself.

Since the decay characteristic of the phosphor is nearly exponential (of the e^{-x} form), compensation can easily be attained by means of simple resistance-capacitance combinations (R-C circuits). If the distorted wave form, figure 9, is now introduced into the compensated amplifier, the output wave, if viewed on an oscilloscope, will appear as shown in figure 10. It can be readily seen that this pattern approaches the ideal condition safely within the accuracy of measurement.

Thus by employing simple compensating circuits, the signal leaving the preamplifier can be made to represent the true video signal of the televised film, and good picture definition will result.

SUPERPHOSPHATE FROM THE TVA

(*Continued from page 117*)

In order to allow the reaction of the phosphate dust and acid to proceed to completion, the superphosphate is stored for two to four months, and is then disintegrated and bagged for shipment.

The second phosphatic fertilizer is calcium metaphosphate. This is produced by passing a stream of volatilized P_2O_5 upward through a vertical column of rock phosphate fragments heated to approximately 1200° C. The metaphosphate is liquid at this temperature and runs out of the lower end of the column, forming a translucent glass upon cooling. In 1946, 8,100 tons of metaphosphate were produced in TVA plants. Superphosphate production was 68,000 tons. In addition, about 2,300 tons of elemental phosphorus were shipped to the Chemical Warfare Service.

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2. "Ride each other's camel!"

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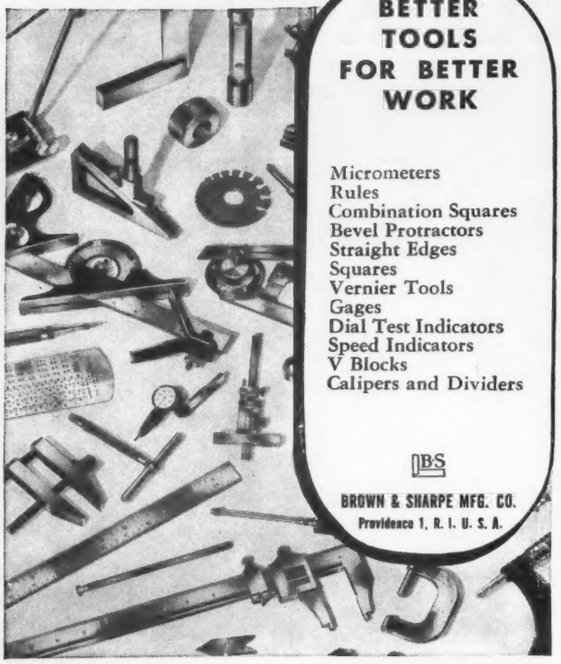
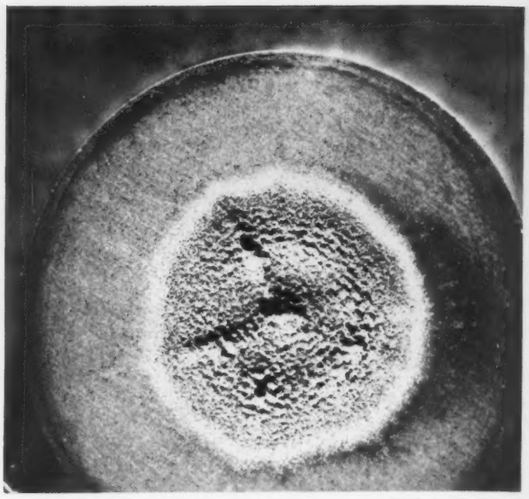


BROWN & SHARPE TOOLS



Cavitation Laboratory

Cavitation erosion produced in a metal sample by the apparatus at M. I. T.

CAVITATION

(*Continued from page 110*)

Other work done with the M. I. T. instrument has shown that cavitation can be made to take place in light lubricating oils. In this medium cavitation has been produced on bearing materials.

Since it is impossible to avoid cavitation in some applications, it is important to develop alloys which are as resistant to erosion as possible. To this end, the cavitation laboratory exposes metal samples submitted by industrial firms to the effects of artificially produced cavitation.

A third type of cavitation testing apparatus produces no actual cavitation. A pure impact is set up by a jet of water which strikes samples affixed radially to a rotating disk.

A modification of the water impact machine is being developed at the M. I. T. cavitation laboratory. The instrument is being constructed to produce and measure simple pressure waves and to determine the effect of the steepness of the wave front (the speed with which the pressure builds up) and the amplitude of the wave on cavitation erosion.

Professor Rightmire is building a machine similar to one built here previously, in that it utilizes a motor-driven hammer at one end of a liquid-filled pipe to produce the pressure wave. However, to permit accurate measurement of the wave front, care is being taken to eliminate, as far as possible, the reflection of the wave from the end of the pipe. For this purpose, a specimen with small cross-sectional area compared to that of the pipe is placed in the tube, and the major portion of the tube downstream

(*Continued on page 132*)

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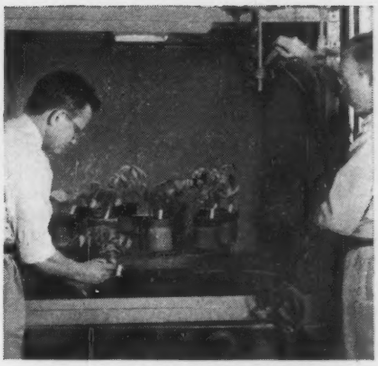
DU PONT Digest
For Students of Science and Engineering

Rubber accelerators lead the way to new agricultural fungicides



B. L. Richards, Jr. Ph.D., Cornell '44, and A. H. Goddin, M.S., University of West Virginia '32, test efficiency of "Parzate" fungicide in control of tomato late blight and bean rust. Equipment is specially designed laboratory spray chamber.

Vulcanization accelerators for rubber and agricultural fungicides would seem to have little in common. But the wide variety of interests of men in the Du Pont organization sometimes result in outstanding developments from such apparently unrelated products.

A rubber chemist suggested to a plant pathologist that derivatives of dithiocarbamic acid, NH_2-C(S)SH, parent substance of a well-known group of rubber accelerators, be tested as insecticides. His suggestion was based on the possibility that sulfur combined in this form might be more effective than free sulfur, a recognized insecticide.

Entomologists and plant pathologists investigated the fungicidal as well as the insecticidal properties of this group. One of the first compounds tested, sodium dimethyldithiocarbamate, $(CH_3)_2$N-C(S)SNa, even in dilutions of 1:30,000, was found to be a powerful fungicide, but somewhat injurious to plant life.

This led to a systematic program of research including other metallic salts, the ethyl, propyl, butyl, phenyl, and other aryl derivatives of the dithiocarbamates and thiuram mono- and disulfides, and the related compounds made from ethylenediamine and morpholine. In this phase of the work, organic chemists played an important role by suggesting various derivatives and preparing them for tests. Later, in cases where proper dispersion and adherence of the compounds to plants were important, the skill of physical chemists was called upon.

In general, the compounds of greater chemical stability were found to be less effective. Fungicidal efficiency diminished with increase in size of alkyl radical, and as aryl radicals were substituted for alkyl. Thus the unusual situation developed that with the exception of the bisethylene (dithiocarbamates), the first and simplest products tested, the methyl derivatives, proved to be the best fungicides.

Iron and zinc dimethyldithiocarbamates, $(CH_3)_2NC(S)$-S-M-S-$(S)CN(CH_3)_2$, are now sold as "Fermate" fungicide and "Zerlate" fungicide respectively, for control of fungous diseases of many fruit and vegetable crops, tobacco, flowers and other ornamentals. Zinc ethylenebis(dithiocarbamate), $Zn(-SC(S)NHCH_2CH_2NH(S)CS-)$, marketed as "Parzate" fungicide, has specific action in the control of late blight on potatoes and tomatoes. Tetramethylthiuram disulfide, $(CH_3)_2NC(S)$-S-S-$C(S)N(CH_3)_2$, is used in two compositions, as "Arasan" disinfectant for seeds and "Tersan" fungicide for turf diseases.

Overall, the derivatives of these groups of compounds proved to be outstanding as fungicides, rather than as insecticides. Although a marked degree of specificity for different pests was characteristic of the members of this series, it is interesting to note that all three were highly effective. This work offers still another example of how the breadth of interest in a company like Du Pont can lead to worthwhile developments.

Field testing of promising fungicides, including "Parzate" formulations, for control of tomato late blight.

Questions College Men ask about working with Du Pont

What are the opportunities for research men?

Men qualified for fundamental or applied research are offered unusual opportunities in facilities and funds. Investigations in the fields of organic, inorganic and physical chemistry, biology, parasitology, plant pathology and engineering suggest the wide range of activities. Write for booklet, "The Du Pont Company and the College Graduate," 2521-A Nemours Building, Wilmington 98, Delaware.

DU PONT
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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

More facts about Du Pont — Listen to "Cavalcade of America," Mondays, 8 P.M., EST on NBC

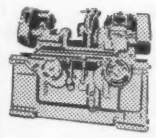
Here's What NORTON Makes . . .

To Serve Many Industries in Many Fields

Abrasive Products

Grinding wheels of ALUNDUM*, CRYSTOLON* and diamond abrasives; discs and segments; bricks, sticks and hones; mounted points; abrasives for polishing, lapping, tumbling and pressure blasting; pulpstones.

Grinding and Lapping Machines



A varied line of machines for production-precision grinding and lapping and for the tool room — including special machines for crankshafts, camshafts, rolls and car wheels.

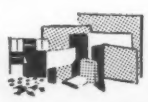
Refractories

High temperature refractories—grain, cement, bricks, plates, tile, tubes — for metal melting, heat treating and enameling; for ceramic kilns; for boiler furnaces and gas generators; for chemical processes; refractory laboratory ware; catalyst carriers; porous plates and tubes.

Norbide*

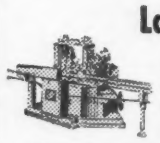
Trade-mark for Norton Boron Carbide — the hardest material made by man. Available as an abrasive for grinding and lapping; in molded products for extreme resistance to wear — especially effective for precision gage anvils and contact points; and for metallurgical use.

Norton Floors



ALUNDUM* Floor and Stair Tile, ALUNDUM* Ceramic Mosaic Tile and ALUNDUM* Aggregates to provide permanently non-slip (wet or dry) and extremely wear-resisting floor and stair surfaces.

Labeling Machines



Single and duplex automatic labeling machines for applying labels and foil to beverage bottles and food, cosmetic and drug containers.

Oilstones and Coated Abrasives

Sharpening stones and abrasive papers and cloth for every use of industry and the home craftsman. Products of the Norton Behr-Manning Division, Troy, New York.

NORTON COMPANY
WORCESTER 6, MASS.

NORTON

Trade Mark Reg. U. S. Pat. Off.

CAVITATION

(*Continued from page 130*)

from the sample filled with glass wool. Practically all of the energy of the wave passes into the glass wool and is absorbed by its damping action.

To measure the wave front, a dural rod is set in the side of the pipe with its end flush with the inner wall of the pipe. Around the outside end of the rod, a wire strain gauge is attached to measure the strain produced in the rod by the passing wave front. The change in resistance of the strain gauge is measured by an oscilloscope connected with a high-gain voltage amplifier. To prevent any reflection of the wave by the dural rod, a lead rod is connected end-to-end at the outside end of the dural rod. There is no reflection at the lead-dural junction, and the energy passes directly into the lead where it is dissipated.

KAEMPFELBACH BRIDGE

(*Continued from page 126*)

The two main trusses have a distance (d) of 200 inches, o.c., and the minimum steel area in each single truss (A) is about 100 square inches. Thus, the moment of inertia, neglecting the moment of inertia of the truss cross-section about its own center of gravity, is, approximately, the product of the steel cross-section area ($2A$) and the square of half the distance (d) between the trusses:

$$I = 2A(d/2)^2 = 2{,}000{,}000 \text{ in.}^4$$

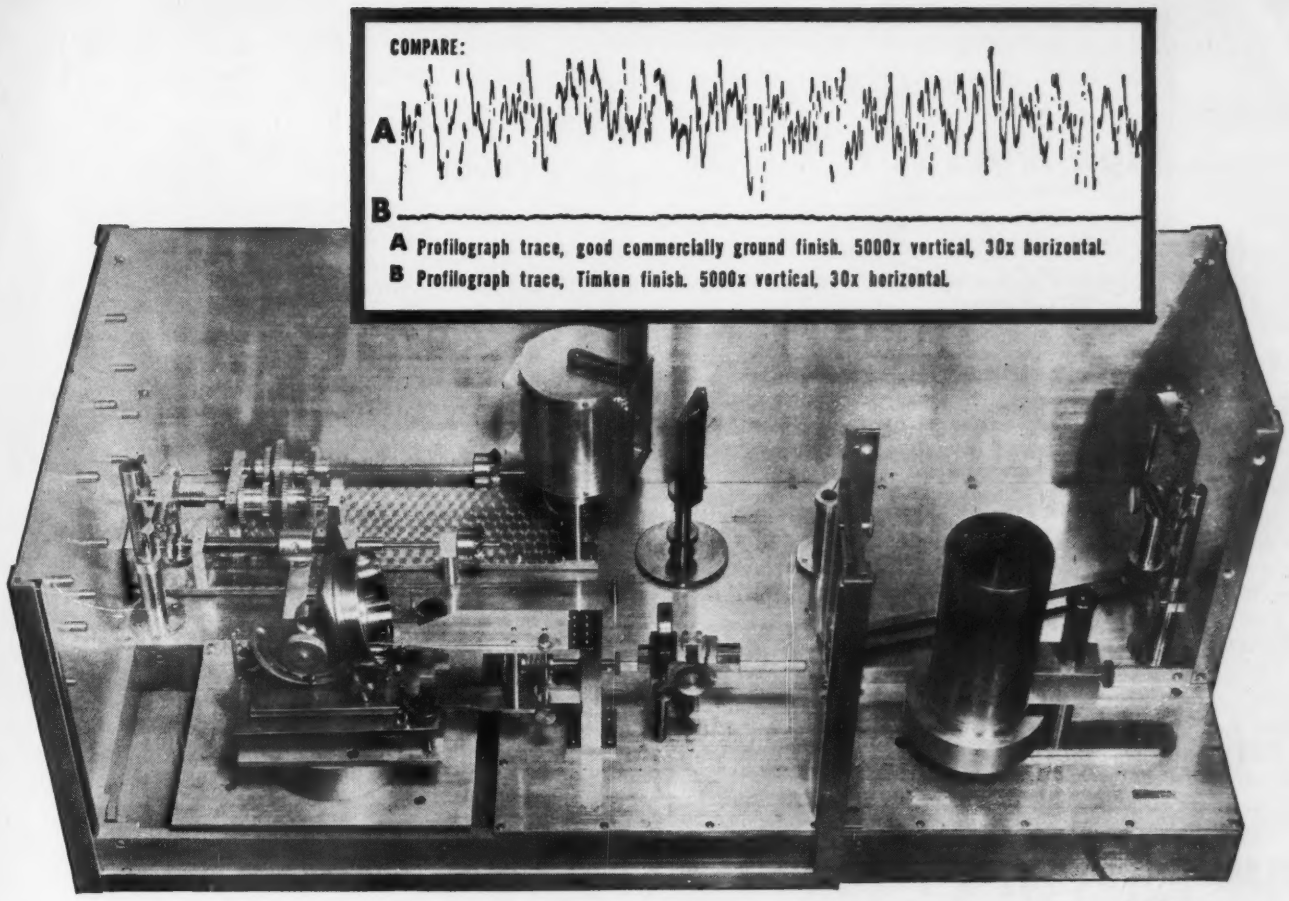
$$P = \frac{1 \times \pi^2 \times 30{,}000{,}000 \times 2{,}000{,}000}{2\frac{1}{2} \times 672^2 \times 144}$$

$$= 3{,}700{,}000 \text{ lb.}$$

$$= 1{,}850 \text{ tons}$$

The steel is subject to bending stresses in addition to stresses due to buckling. However, the allowable load limit in case of buckling, as computed above, is 1,850 tons or almost ten times the anticipated load. Therefore it can be assumed that the bending stresses and stresses due to wind load will not be augmented substantially, and that the heavy "SKR" bridge can safely absorb this increase in stress.

As the present bridge is slated to be in use for at least twenty years, the adoption of the counter thrust lever appears to be advisable, and its installation will insure positive safety against any dangers of further pier and arch deflections, with no special maintenance requirements.


COMPARE:
A
B
A Profilograph trace, good commercially ground finish. 5000x vertical, 30x horizontal.
B Profilograph trace, Timken finish. 5000x vertical, 30x horizontal.

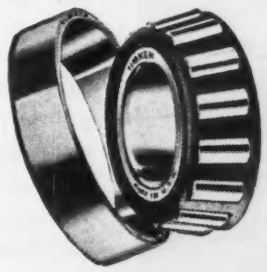
Answers the question— "How rough is smooth?"

ONE of the reasons Timken Tapered Roller Bearings perform with such frictionless, wear-free ease is the amazingly smooth surface finish on the rolls and races —the finest known to modern bearing science.

Now, when you talk about finishes like this, you're talking about surface irregularities of only a few millionths of an inch — irregularities which are impossible to detect by any ordinary means. So, when Timken first began to develop this finish, one of the biggest obstacles was the absence of an accurate method of measuring the roughness of an apparently smooth surface.

The profilograph pictured above was the answer. Developed by Timken in 1928 and steadily improved since then, the profilograph determines surface irregularities to within one-millionth of an inch. Equipped with this measuring stick, Timken engineers were able to develop new finishing methods and machines, which have resulted in the microscopic surface accuracy of the Timken Bearings you use today.

Every factor in the efficiency of a bearing is approached at Timken in this same scientific manner. For example, Timken makes its own steel to assure constant quality. And Timken is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels. No wonder you can always be sure of uniformly top quality and performance in the Timken Bearings you use. The Timken Roller Bearing Company, Canton 6, Ohio.



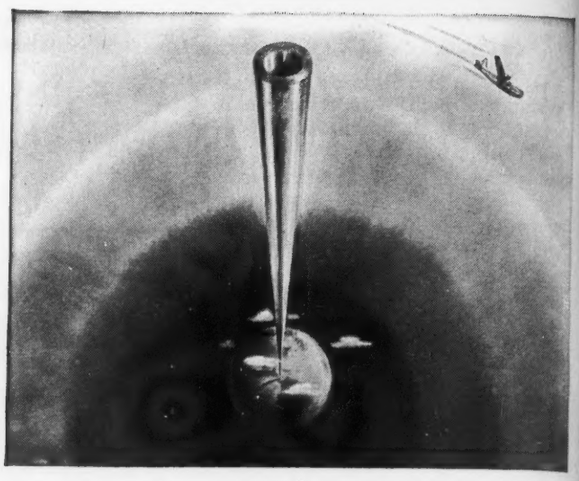
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Pipe line . . .

to the Stratosphere



Up in a stratosphere plane you'd breathe oxygen from a tank . . . oxygen extracted from liquefied air. Processing equipment in which the extraction takes place calls for something extraordinary in the way of tubing.

Ordinary steel tubes get hazardously brittle in the 315-below-zero temperature the extraction process demands—crack like a crisp carrot. Better, safer, tubes were needed. Industry got them—from B&W—tubes made of new nickel-alloy steels.

B&W calls these new tubes Nicloys. In refrigeration, in making synthetic rubber, in handling natural gas and strongly corrosive crude oils, in paper mills, industry is finding that Nicloy tubes answer many tough problems.

Development of Nicloy tubing is another manifestation that, for all its years, B&W has never lost the habit of having new ideas for all industries.

To technical graduates, B&W offers excellent career opportunities in diversified phases of manufacturing, engineering, research, and sales.

N-29

THE BABCOCK & WILCOX TUBE CO. Main Office: Beaver Falls, Pa. Plants: Beaver Falls, Pa. & Alliance, Ohio.

A GOOD NAME TO CALL ON

NATIONAL ELECTRIC PRODUCTS — WIRING SYSTEMS — WIRES AND CABLES

➡ FOR WIRES AND CABLE

➡ FOR RACEWAYS AND FITTINGS

THE WORLD'S LARGEST PRODUCER OF ELECTRICAL ROUGHING-IN MATERIALS

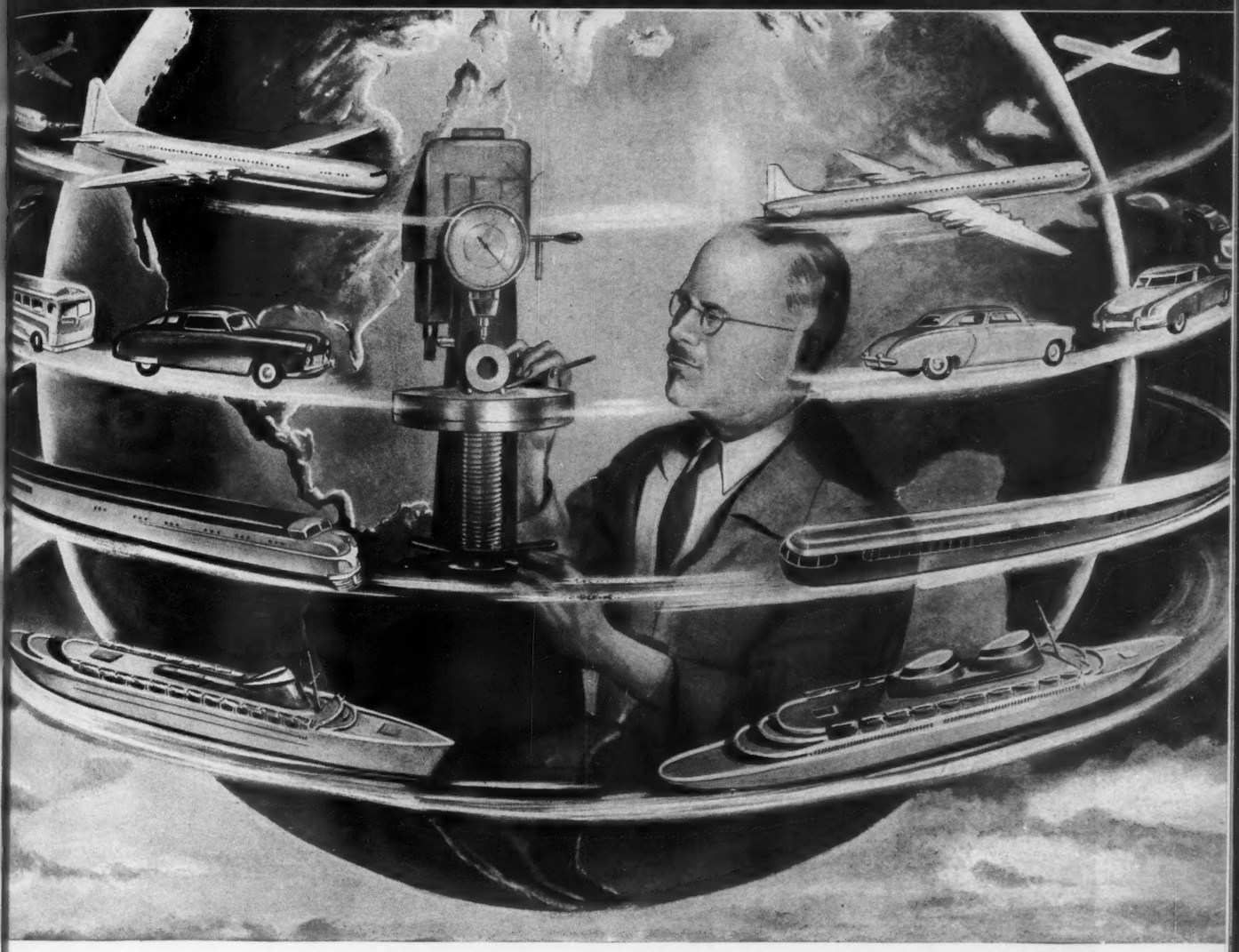
National Electric Products Corporation
Pittsburgh 30, Pa.

WORKER RELATIONSHIPS

(*Continued from page 113*)

One might summarize this experiment by saying that it indicates that experiments in this area are possible, that it is not difficult to measure quantitatively the results of certain social factors in work situations. It also raises certain quite interesting questions which seem to be approachable experimentally. Why do some individuals in the absence of direct cues as to rate of work gravitate to a stable rate — some fast, some slow? Why does this difference occur? Is it related to personality? Or is it the result of habits which apply generally to any work situation? One might ask, also, whether the effect on rate when slow dominant and fast workers are paired can be considerably altered by changing the situation in which these people are put. What would happen for instance if the slow dominant worker were put "in charge"? What would happen to the rate of work if the fast worker were in charge? What would be the effect on both workers in the paired situation if they were given a standard to work against? There are no theoretical or methodological difficulties to prevent the answering of these questions by further experimentation. However, the task of translating these laboratory findings into industrial practice remains to be done by the alert and progressive manager of industry itself.

"—Many shall run to and fro, and knowledge will be increased"—DANIEL XII, 4.



Why transportation gets better all the time

OVER SIX HUNDRED MILES AN HOUR in the air, four hundred on land, one hundred on water—these are the speeds that are telescoping time and space today.

The world shrinks and shrinks . . . Distances that were once days, weeks, months away are now a matter of hours. What things behind the scenes have brought these whirlwind developments in transportation?

There's chromium, for one. Basis of stainless steel, it toughens planes, cars, trains . . . insures added safety . . . yet makes them lighter throughout.

There are special carbon brushes necessary to the operation of some thirty motors and generators used in the control apparatus of modern transport planes. These brushes must be built to stand up under the pressures of high altitude flying.

Colorful plastics, too, lend their lightness, give their strength, safety and serviceability.

And gasoline now gives more power—has more get-up-and-go—takes you farther at less cost . . . thanks to new vitalizing chemicals.

Producing these better materials and many others—for the use of science and industry and the benefit of mankind —is the work of the people of UNION CARBIDE.

FREE: *You are invited to send for the illustrated booklet, "Products and Processes," which describes the ways in which industry uses UCC's Alloys, Carbons, Chemicals, Gases and Plastics.*

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PRESTONE AND TREK ANTI-FREEZES • ELECTROMET ALLOYS AND METALS • HAYNES STELLITE ALLOYS • SYNTHETIC ORGANIC CHEMICALS

Another important pigment for rubber –
CALCENE T
$CaCO_3$ 94% min.
$MgCO_3$ 3.5% max.
Coating Agent 2.1±0.2%
Inorganic Insoluble in HCl 0.75% max.
Moisture 0.30% max.
Loss on Ignition 46-47
Specific Gravity 2.7
Particle Size Avg. 0.45 Micron
Screen test 0.3% max. on 325 mesh
Alkalinity Less than 0.02% as Na_2O
Bulk Density 35 to 40 lb. per cu. ft.
Columbia's Technical Staff expands the use of Calcene T through continual development of new data

Calcene T is a precipitated calcium carbonate of fine particle size. Light cream to white in color, the surface is coated with approximately 2% Tall Oil to increase ease of dispersion and wetting by elastomers in compounding rubber stocks. It confers good tensile strength and tear resistance without undue stiffening and is used to advantage in such products as inner tubes, tire carcasses, footwear, drug sundries, insulated wire and other molded, mechanical and extruded goods.

Calcene T is also used as a loading ingredient in vinyl plastics. New data is being developed continually and markets are broadening through the coordinated efforts of Columbia's entire Technical Staff . . . Research, Development, Technical Service, Market Research and Development.

PITTSBURGH PLATE GLASS COMPANY, COLUMBIA CHEMICAL DIVISION, Fifth at Bellefield, Pittsburgh 13, Pa. Laboratories, Barberton, Ohio. District Offices, Chicago, Boston, St. Louis, Pittsburgh, New York, Cincinnati, Cleveland, Minneapolis, Philadelphia, Charlotte, San Francisco. Manufacturers of alkalies and related products, including Soda Ash, Caustic Soda, Liquid Chlorine, Sodium Bicarbonate, Calcium Chloride, Caustic Ash, Modified Sodas, Phosflake, Calcene T, Silene EF, Pittchlor and Pittcide.

COLUMBIA CHEMICALS

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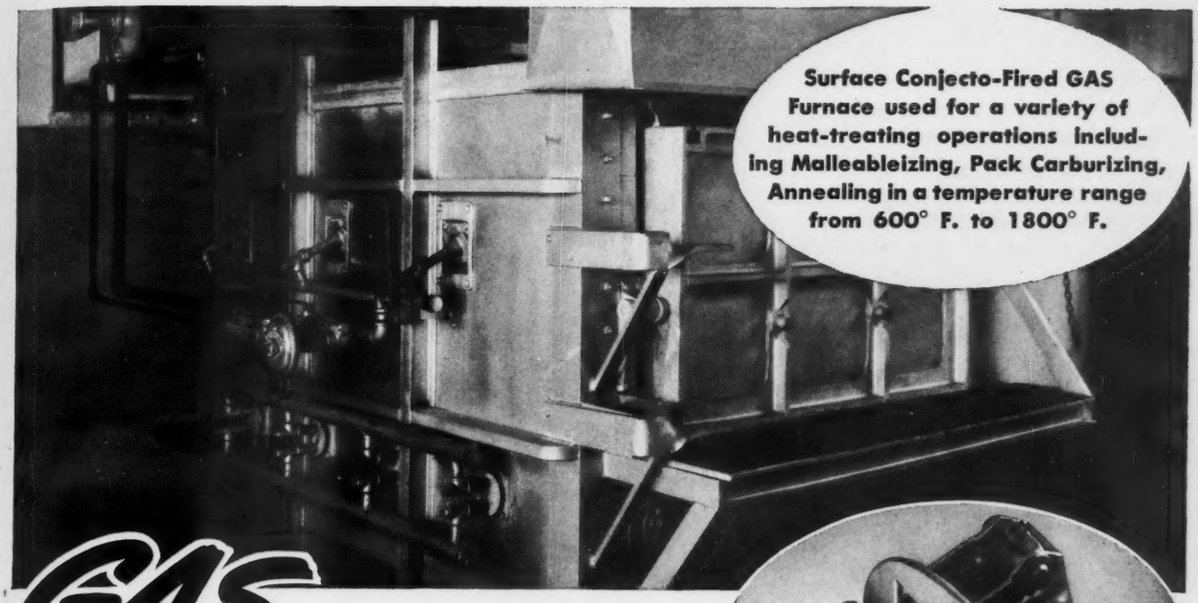
PITTSBURGH PLATE GLASS COMPANY



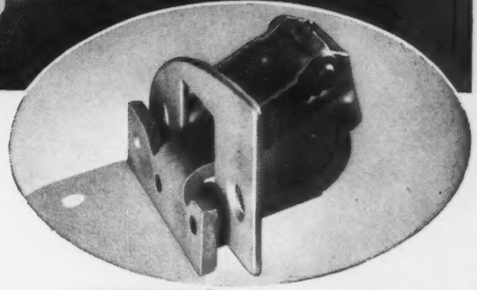
Surface Conjecto-Fired GAS Furnace used for a variety of heat-treating operations including Malleableizing, Pack Carburizing, Annealing in a temperature range from 600° F. to 1800° F.

GAS FURNACE PERFORMS MULTIPLE HEAT-TREATING FUNCTIONS UNDER VARIED CONDITIONS

In modern heat-treating, adaptability of equipment and flexibility of fuel are primary influences in any cost-per-piece analysis. As a typical example of the flexibility of the productive flames of GAS, this Conjecto-Fired GAS Furnace is used for a variety of operations without any change other than regulation of the fuel-mix and temperature controls.

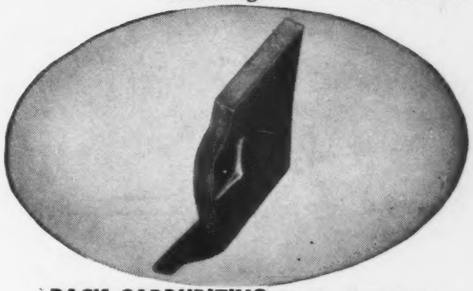
Atwood Vacuum Machine Company, Rockford, Illinois, is equipped to heat-treat pieces ranging from 1 ounce to 1000 pounds, in volume up to 15,000 pounds daily. Their modern Gas-fired Equipment is adapted for annealing, carburizing, drawing, hardening, normalizing, malleableizing, stress relieving, under rigid metallurgical specifications.

Experienced heat-treating specialists like Atwood Vacuum Machine Company use GAS because this flexible, controllable, rapid-heating fuel is so readily adaptable to all types of processing at any required temperature. The productive flames of GAS are so flexible that they can be used for any production-line heating operation, under the most exacting conditions.



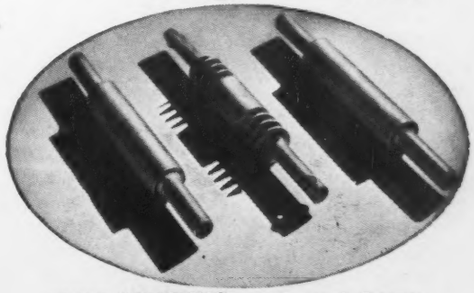
ANNEALING—Station wagon body hinge

Material:	SAE 1020
Temperature:	1600° F.
Time Cycle:	36 hours
Net charge:	6400 lbs.



PACK CARBURIZING—Brake Trunnions

Material:	Hot rolled SAE 1010
Temperature:	1650° F.
Time Cycle:	8 hours
Case:	.040
Net charge:	1500 lbs.



MALLEABLEIZING—Trailer Jack Screws

Material:	Malleable Iron
Temperature:	1750° F.
Time Cycle:	72 hours
Net charge:	10,000 lbs.

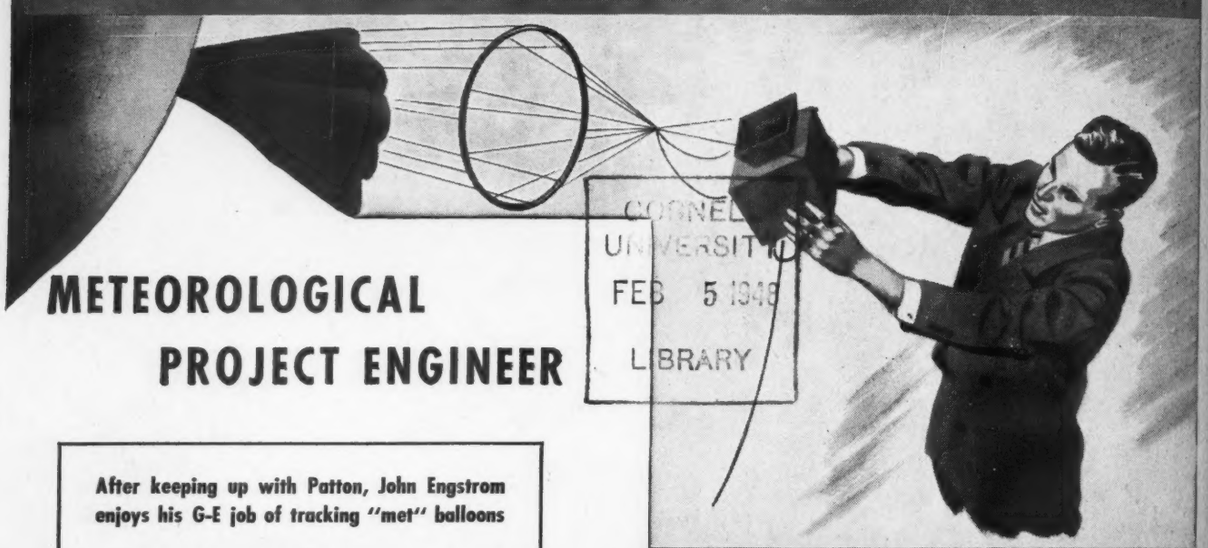
AMERICAN GAS ASSOCIATION

420 LEXINGTON AVENUE • NEW YORK 17, NEW YORK

Data and Photos by SURFACE COMBUSTION CORPORATION, Toledo, Ohio, Manufacturers of Gas Heat-Treating equipment

MORE AND MORE... THE TREND IS TO GAS FOR ALL INDUSTRIAL HEATING

Campus to GENERAL ELECTRIC



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METEOROLOGICAL PROJECT ENGINEER

After keeping up with Patton, John Engstrom enjoys his G-E job of tracking "met" balloons

In February, 1946, after he had happily allowed himself to become "inactive" in the files of the Reserve Army Signal Corps, John Engstrom—a family man with two kids—went looking for his first career-size job.

He was able to rely on the help of an old friend—his knowledge of electronics.

Ever since he started tinkering with radio sets in his teens, John had been doing things in electronics—and electronics had been doing things for him.

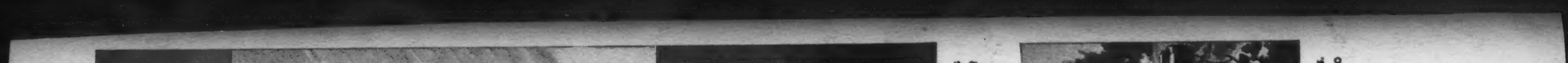
At the University of Minnesota he had earned part of his expenses by servicing radios between hours of studying for a degree in electrical engineering.

Going directly into the Army after his graduation in 1942, John had received further training in electronics at Fort Monmouth, New Jersey, and had been sent on a seven-month electronics assignment to South America. Later he had been assigned to a Signal Corps communication team and had helped provide General George Patton's headquarters with communication during the final victorious drive into Germany. And after V-E Day he had been flown back to the States to head up an investigation team to study the propagation of microwaves in low level ducts over tropical waters.

John Engstrom found his career-size job at General Electric. Reporting to Electronics Park in Syracuse, N. Y., he spent a year in developmental engineering. Today, as project engineer for the Army-Navy Meteorological Program, he is in charge of developing meteorological tracking and measuring equipment—a solid foothold in an electronics future.

For your copy of "Careers in the Electrical Industry," write to Dept. 237-6, General Electric Company, Schenectady, N. Y

John Engstrom admits that his attention perks up when he begins to think about electronics. He paid part of his college expenses at Minnesota servicing radios.

In the Army Signal Corps, he continued his work in electronics. His radio communications team helped keep channels open to Patton during the drive into Germany.

GENERAL ELECTRIC